# MONITORING AND REGULATION OF NORM IN THE SLOVAK REPUBLIC

**V. DRÁBOVÁ**
Public Health Authority of the Slovak Republic, Radiation Protection Department
Bratislava, Slovak Republic
Email: veronika.drabova@uvzsr.sk

**A. ĎURECOVÁ**
Regional Public Health Authority in Banská Bystrica, Radiation Protection Department
Banská Bystrica, Slovak Republic

**Table 1. industries with possible increased exposure to natural sources of ionising radiation**

| WORKPLACES WITH EXPOSURE TO NATURAL SOURCES OF IONIZING RADIATION | WORKPLACES WITH EXPOSURE TO RADON |
|---|---|
| Industrial sectors involving NORM<br>Operations of aircraft and spacecraft, concerning the exposure of crews during the flight with altitude more than 8 km | Underground workplaces<br>Workplaces situated on radon prone areas<br>Workplaces in a building that serves as a pre-school or a school facility, a day-care home, a health care home, or for other commercial purposes for the long-term residence of persons<br>Workplaces where underground water is handled in a way of pumping, cumulating, or in other ways |

**BASED ON THE SOURCES OF INFORMATION MENTIONED ABOVE, THE SLOVAK WHITE LIST THAT HAS BEEN SET IN THE RADIATION PROTECTION LAW INCLUDES WORKPLACES WHERE FOLLOWING ACTIVITIES COULD BE PERFORMED:**

- Mining and processing of ores (other than uranium ores);
- Handling of solid products of coal combustion in installations with a thermal input exceeding 5 MW;
- Production of building materials from the products of coal combustion;
- Manufacture of TiO2 pigments;
- Production of oil and gas;
- Production of tin, copper, lead, iron;
- Exploitation of coal;
- Exploitation of raw materials with the content of niobium, tantalum, and zircon;
- Management of naturally occurring radioactive materials for which the natural radionuclide content has been shown to exceed release levels or to increase the dose rate above 0.5 microSv.h-1;
- Using of geothermal energy;
- Handling with sediments, filters and etc., from water treatment plants (groundwater is treated);
- Handling with underground water in a way of pumping, cumulating, or in other ways, and workplaces the activities mentioned above are performed in closed spaces.

The list is not exhaustive and may be supplemented by other activities if identified by the Public Health Authority of the Slovak Republic after the campaign and the implementation of the strategies of the National Action Radon Plan of the Slovak Republic.

## EXPOSURE OF WORKERS IN WORKPLACES WHERE GEOTHERMAL ENERGY IS USED

Geothermal energy has been known and used in varying methods for centuries. Records show that the Chinese, Romans, Japanese, Turks, Icelanders, Central Europeans and the Maori of New Zealand have used the resource for heating, bathing and cooking. These uses continue. Generally, five types of direct uses of geothermal energy can be identified [3], i.e.:

— Aquaculture (fish farming and algae production);
— Geothermal Heat Pumps (Residential and District Heating);
— Uncovered Ground Heating – Greenhouses and Covered Ground Heating;
— Industrial Uses (Drying and warming agricultural products); and
— Balneology (Hot springs, spa bathing).

Above mentioned industrial sectors using geothermal energy are listed in the Slovak white list and could cause exposure to workers to natural sources of ionizing radiation. 141 geothermal boreholes have been already identified in the territory of the Slovak Republic. Geothermal energy is used for space heating in towns in the Slovak Republic. For recreation, balneotherapy and swimming pools is used much more, in 2 localities geothermal water is used for fish hatchery purposes and for greenhouses heating in 10 localities. The distribution of the utilization of geothermal energy in the Slovak Republic from 114 wells at 74 sites in 2020 can be viewed in Fig. 4 [4].

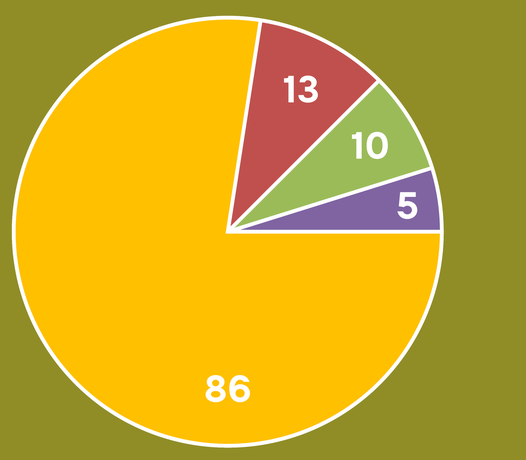



FIG. 4. UTILIZATION OF GEOTHERMAL ENERGY IN THE SLOVAK REPUBLIC.

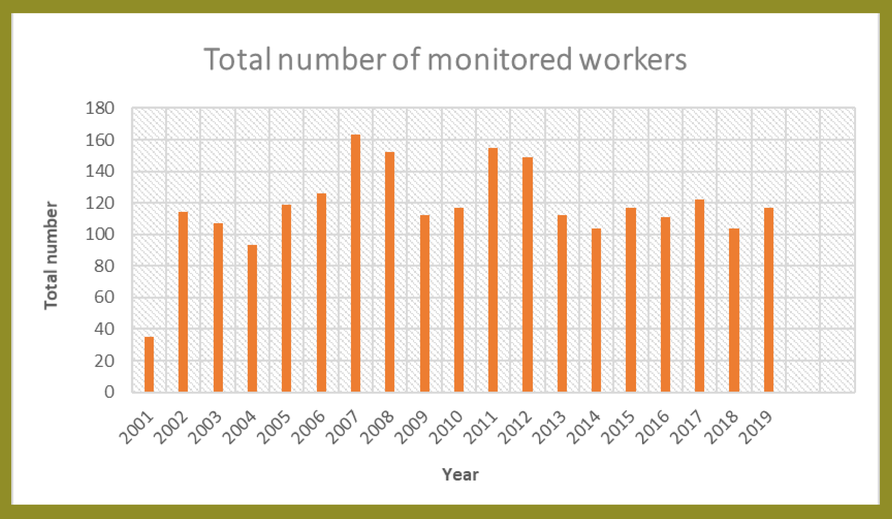



FIG. 1. TOTAL NUMBER OF MONITORED WORKERS.

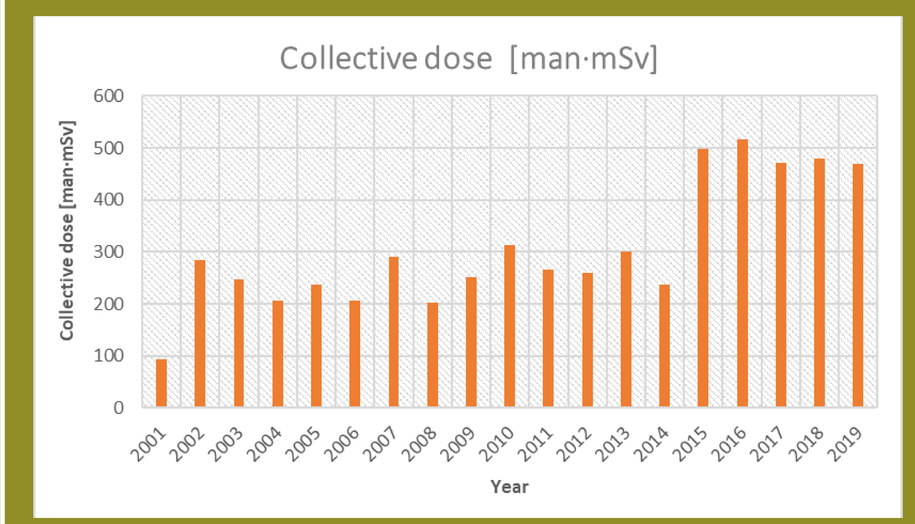



FIG. 2. COLLECTIVE DOSES OF MONITORED WORKERS.

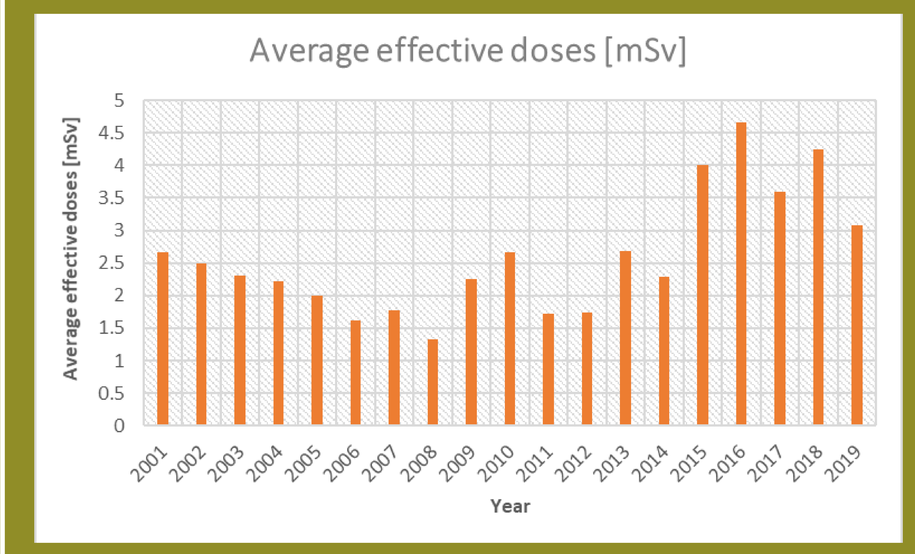



FIG. 3. ANNUAL AVERAGE EFFECTIVE DOSES OF MONITORED WORKERS.

## ABSTRACT

Exposure to naturally occurring radionuclides is responsible for the majority of an average person's yearly radiation dose and therefore it is not usually considered of any special health or safety significance. However, certain industries handle significant quantities of NORM which usually ends up in their waste streams. The Public Health Authority of the Slovak Republic is the national authority in the field of radiation protection and was charged for the implementation of the European Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation (hereinafter „Directive 2013/59/Euratom") including the NORM related sections. Resulting from the Directive 2013/59/Euratom, the Slovak Republic has adopted Act No. 87/2018 Coll. On Radiation Protection (hereinafter "radiation protection act"). There is no definition of NORM in the Slovak legislation, but in the radiation protection act „Practices leading to exposure of workers or members of the public to natural sources which cannot be disregarded from a radiation protection point of view" are defined. For the identification of industrial processes where NORM may occur, Directive 2013/59/Euratom and IAEA publications were taken into account. Based on these sources of information, the Slovak white list that has been set in Article 123 of the radiation protection act includes two subsections for NORM. There is as yet little consistency in NORM regulations among industries and countries. This paper addresses some of these industrial processes, including NORM, that are defined in the Slovak legislation. Over time, as potential NORM hazards have been identified, these industrial processes have increasingly become subject to monitoring and regulation and under certain conditions, they are subject to the requirements for an existing or planned exposure situation.

## ADOPTION OF THE SLOVAK WHITE LIST

The Slovak white list includes two subsections for industries involving naturally occurring radioactive materials, which potentially increase the exposure due to radon, uranium, thorium and their progenies and work activities, where residues that are produced with elevated levels of natural radionuclides may lead to a significant increase in the exposure of workers and the members of the public, as indicated in Table 1.

## APPROACH FOR EXPOSURE ASSESSMENT AND DOSES OF WORKERS IN UNDERGROUND WORKPLACES

There are currently two types of underground workplaces with exposure to natural source of ionizing radiation (mainly with exposure to radon) in the Slovak Republic. These are former mines that currently serve as museums and caves. Slovak Republic is full of beautiful caves and underground places. There are over 7 500 known caves of which 45 are open to the public and 13 of them are show caves accompanied with the guide – what makes them workplaces of a regulatory body's concern.

Public Health Authority of the Slovak Republic maintains the national registry of doses, records and keeps doses of up to 16 000 workers every year. Approximately 150 of monitored workers are classified as category A workers who are exposed to natural sources of ionizing radiation as can be seen below in Fig. 1.

Due to the coronavirus pandemic and restrictons taken to protect the public health, the cave attendance in 2020 decreased to a quarter compared to the previous years. Solid state nuclear track detector CR 39 have been used for individual monitoring of doses of workers in workplaces with exposure to natural sources of ionizing radiation. Collective doses of monitored workers have been in at the level of 500 man·mSv per year as shown in Fig. 2.

Existing measurements capacity is not sufficient enough. There are only 6 organizations with a valid registration issued by the Public Health Authority of the Slovak Republic that can perform monitoring of workplaces, personal monitoring and authorized dose assessments in workplaces with exposure to natural sources of ionizing radiation. All the registered organizations should follow approved protocols and methods, such as ISO 11665 – 4:2020 Measurement of radioactivity in the environment — Air: radon-222 — Part 4: Integrated measurement method for determining average activity concentration using passive sampling and delayed analysis, STN ISO 11665 – 5:2020 Measurement of radioactivity in the environment — Air: radon-222 — Part 5: Continuous measurement methods of the activity concentration, and must apply graded approach that is described in Decree No. 98/2018 Coll. on the limitation of exposure of workers and population from natural sources of ionizing radiation. Recommendations on dose/exposure assessment methods and records keeping of ICRP Publication 137 [1] and Radiation Protection Publication 193 - Radon in workplaces are taken into account [2]. Dose coefficient expressed in terms of Rn-222 gas exposure depends on the equilibrium factor, F, between radon gas and its progeny. Using the standard assumption of F = 0.4 for most indoor situations, this dose coefficient corresponds to 6.7 10 – 6 mSv (Bq.h.m -3 ) -1 . Annual average effective doses of monitored workers vary in the range from 1 – 5 mSv as shown in Fig. 3.

## CONCLUSIONS

There is a need for international consensus on NORM exposure management and that industries involving NORM have been regulated variably regarding radiological protection, because the radiological protection system has been introduced after the start of operation, and existing industrial hygiene controls already limit the potential for radiation exposure. Exclusion and exemption of industries involving NORM and activities using numerical criteria may be useful but lack the quantitative judgement that is also often necessary. Hence a graded approach in the management of NORM exposure, considering the prevailing circumstances and the risk to people, with the global aim of promoting the protection of workers health.

***REFERENCES***

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