I/10
ONGOING CASE STUDIES ABOUT THE IMPLEMENTATION OF THE EUROPEAN BASIC SAFETY STANDARDS IN BELGIUM

A. Van Deynse, A. Poffijn*,+, J. Buysse**

**University Gent, Radiation and Environmental Physics, Proeftuinstraat 86, B-9000 Gent*

+Ministry of Public Health, DBIS, Rijksadministratief Centrum, B-1010 Brussel.

Abstract

The date of implementation of the European Basic Safety Standards in the national legislation is approaching. The impact of the implementation is rarely studied in Belgium. Therefore some case studies in different sectors of the non-nuclear industry are currently carried out. We selected the cases in different areas of concern. First we have investigated systematically the situation in the phosphate industry because they use raw material containing enhanced values of radionuclides. Secondly measurements are carried out in underground workplaces. Special attention is paid to a schiefer mine in Belgium. And third attention is paid to the storage of radioactive minerals. As an inheritance of the Belgian colonial past there are a lot of radium and uranium containing minerals from Katanga imported in Belgium. Most of them are stored in galleries or university laboratories, causing enhanced radon concentrations and gamma-activities.

Introduction

The date of implementation of the European Basic Safety Standards (BSS) in the national legislation is approaching. The impact of the implementation is rarely studied in Belgium. A lot of industrial activities may release important quantities of radon gas. Particular groups of workers may incur relatively high doses due to the alpha emitting short-lived decay products of radon. Results of epidemiological studies among miners demonstrate clearly the correlation between radon exposure and lung cancer incidence. Besides this the gamma-radiation can also be enhanced due to the presence of (natural) radioactive materials.

In order to evaluate the impact of the implementation of the BSS, some case studies in different sectors of the non-nuclear industry are currently being carried out. Attention is paid to industrial activities with high contents of natural radionuclides in the raw materials and end products. Furthermore attention is paid to some underground workplaces and the storage of radioactive minerals in galleries or university labs. The aim of this research is to evaluate the possible health risks caused by natural radioactivity. Combinations of both radon and gamma radiation can give results above the action level of the BSS.

The phosphate industry

The situation in the phosphate industry is investigated systematically in all firms in Belgium. First attention is paid to the natural radioactive content of the raw material and the end and waste products. Afterwards radon measurements are carried out at the different working areas where the workers spend most of their time [1]. Two different production processes are used, one using HCl and the other using H_2SO_4. The results show a great dependence on the natural radioactive content of the raw material and the production process. Phosphate ore from sedimentary origin in combination with the specific production process, causes enhanced values in the Rn-222 concentration (> 400 Bq/m^3). Further control measurements are performed in the firm of concern and summarised in Table 1.

Table 1: **Radon measurements in different working areas.**

	Radon concentration (Bq/m^3)			
Working area	**spring**	**autumn**	**winter**	**Sept-April**
Storage of phosphate ore	253 ± 12 78 ± 4	191 ± 40	186 ± 48	248 ± 83
Storage of the end product	35 ± 4			
Dehydration of the waste product	269 ± 20	525 ± 96	782 ± 245	761 ± 145
Storage of the waste product	144 ± 6	100 ± 15	69 ± 11	95 ± 4
Background value	19 ± 7			

From Table 1 we can conclude that the season variation in the dehydration building, where there are continuously workers present, is great. This indicates mostly on a lack of ventilation. Therefore measurements using active devices were done with and without extra aeration. The extra aeration was opening the door in combination with a little fan. These measurements are performed in summer time. The results are shown in Figure 1. The conclusion drawn out of Figure 1 is that an increase in the ventilation is needed to prevent high radon concentrations.

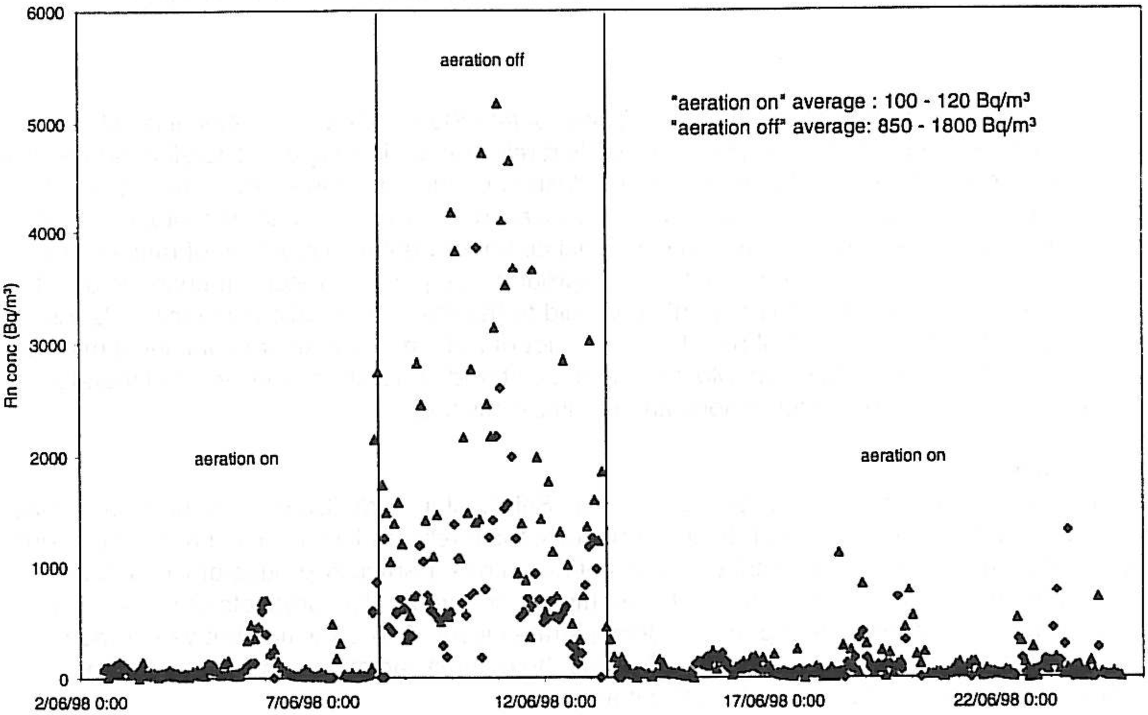

Figure 1: Active measurements with and without aeration.

Beside the radon problem there are also enhanced levels of gamma-radiation due to the radionuclides in the waste products. By dehydrating the silt waste, radium is prevented to stay in the production water. The quantity of waste is greatly decreased by this new process but the radium activity is concentrated in the remaining solid fraction. Values of more than 7000 Bq/kg are found. To estimate the received dose, gamma-measurements are performed at different locations in and around the dehydration building. The results are shown in Table 2.

Table 2: **Gamma-measurements.**

Work location	Gamma-dose rate (μSv/h)
Dehydration building (upstairs)	From 0.09 to 0.26
Dehydration building (downstairs)	From 0.18 to 0.53
Peak value above waste-pipe	1.75 ± 0.09
Storage waste before dehydration	0.88 ± 0.09
Road towards the waste storage	From 0.18 to 0.35
Storage of solid waste fraction	From 2.6 to 4.4
Reference background level (outdoors)	0.09 ± 0.01

Most of the workers work partly at the waste storage and partly in the dehydration building. They will receive an annual dose of about 3.7 mSv. As this exceeds 1 mSv/y attention has to be paid to this situation. Continuously environmental monitoring is carried out by means of passive radon detectors. The gamma-dose level is controlled by personal film dosimeters.

As the occupancy at the different workplaces is not exactly known, the use of a personal radon dosimeter could give a better dose estimation. We opt for passive, integrating measurements during one working month. In order to achieve the necessary sensitivity of the radon dosimeter a combination of activated charcoal and a track-etch detector is used [2]. The activated charcoal adsorbs the radon from the air and the track detector records the alpha particles emitted by radon and its decay products. Different types of activated charcoal are tested [3] in order to become a detector that can measure 50 Bq/m³ in 1 working month [4]. Further optimisation is still needed before the use of this detector in practical situations. Measurements in the phosphate industry are provided for the beginning of 1999.

Underground workplaces

Special attention has to be paid to underground workplaces. The work activity performed in them can be very different. For example a photographer uses the basement of his house as a studio. As the house was in a radon risk area, high radon concentrations were discovered in his "workplace". Not only the dose of the worker has to be taking into account but also the public exposure. These cases indicate that it is difficult to give a conclusive definition of a workplace. The separation between living places and workplaces is sometimes very difficult and the application of the regulation can be ver.v confusing, both for the worker and for the controlling persons.
An underground workplace studied extensively is the last schiefer mine still in operation in Belgium. The investigation is done in the mine itself where the workers have to excavate the raw material. There values of more than 4000 Bq/m³ are found. Next to the mine there is a workshop where the workers cut the schist in slates. The first measurement in the workshop, carried out in October, indicates a value of 900 Bq/m³. Afterwards some active measurements are performed during the winter (Figure 2). They gave the same results for the mine but a rather lower average value in the workshop. This is caused by the use of the heating system that uses outdoor air.

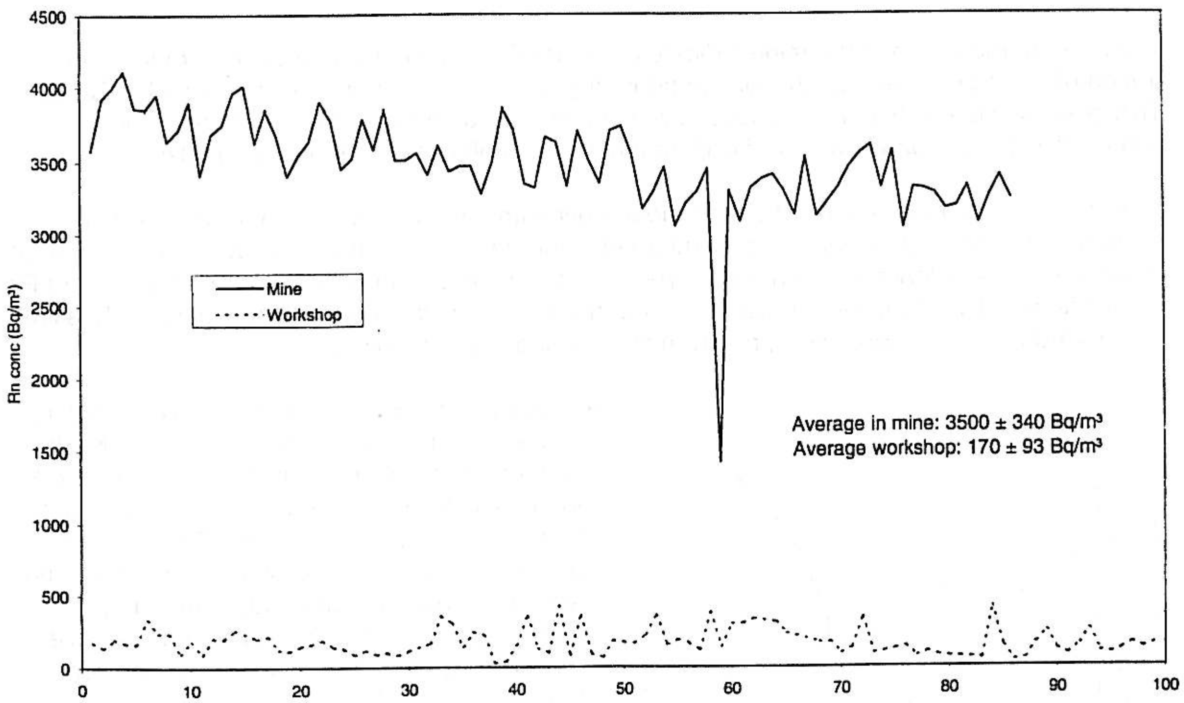

Figure 2: Radon measurement in the mine and workshop.

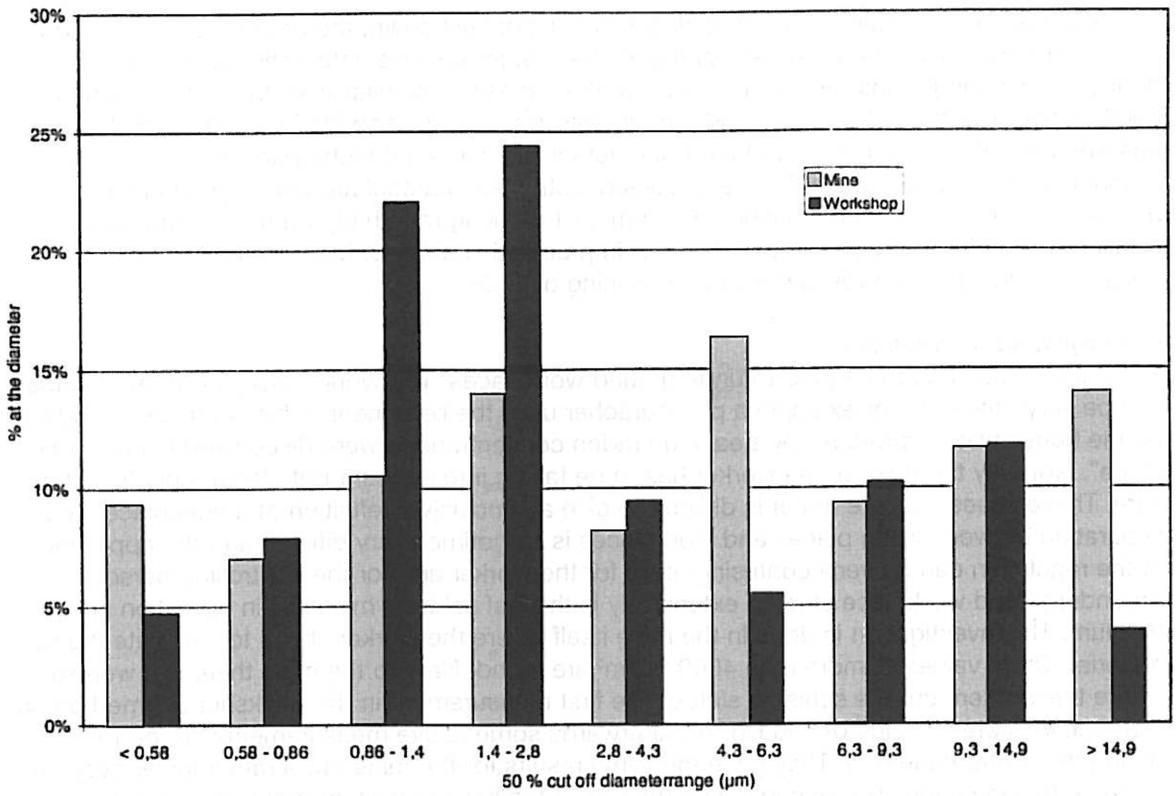

Figure 3: Size distribution of the dust particles in the mine and in the workshop.

The F-factor measured in the mine indicates a value of 0.8. Taking into account a radon concentration of 3500 Bq/m³ and 2000 working hours a year, this gives an annual dose of 44 mSv. [5] This dose is twice as high as the action level in working conditions. This means an excess relative risk of fatal lung cancers of 0.12 or a nominal fatality and detriment of 0.0026.

To examine the source of the enhanced radon concentration, the Ra-content of the shist is examined by means of exhalation measurements and gamma spectroscopy. We found a value of 25 µBq/m²s or 4 µBq/kg s. The gamma spectroscopy indicates no significant enhancement of Ra in the sample. Therefore we can conclude that the shiefer itself is not the radon source. This lets us conclude that the radon will come from the soil and from the mine.

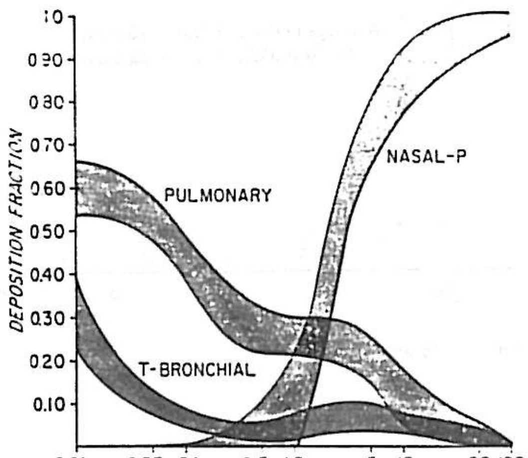

Figure 4: Deposition fraction for a given diameter (tidal volume: 1450 ml, 15 respirations/min) [6]

Beside that the particle mass size distribution is also measured by means of an Andersen Mark impactor (Figure 3). The dust density in the workshop is bigger than in the mine (2.25 µg/l in the workshop, 0.17 µg/l in the mine). But the dust particles are more equally distributed in the mine itself with also an important amount of big particles (> 10 µm). In the workshop is the size of the particles mostly concentrated between 0.9 and 3 µm.

Figure 4 shows that particles bigger than 1 µm are mostly deposited in the nasopharync (nose, pharynx and larynx). The retention time there is very low and clearance is achieved by ciliary-mucus transport within minutes. A part of the particles between 0.5 and 3 µm are also deposited in the pulmonary region (respiratory bronchioles, alveolar ducts, atria, alveoli and alveolar sacs). The retention in there is much longer and can be many weeks dependent on the structure and properties of the particles. It has to be remarked that it is not sure that the radon daughters have the same distribution of the dust particles itself.

Radioactive minerals
As an inheritance of the Belgian colonial past there are a lot of radium and uranium containing minerals from Katanga (Congo) imported in Belgium. Most of them are stored in galleries or at the university laboratories. One case being studied extensively is the Africa museum near Brussels. In the basement large amounts of radioactive minerals are stored. They cause a radon atmosphere in there of about 10 - 15 kBq/m^3 with enhanced ventilation. Higher values can be reached if the ventilation is off. But this is not the basic problem because the occupancy in the cellar is very low. Beside the radon the stored minerals gives also rise to very high gamma levels. Above the cellar is the house of the caretaker of the museum, where gamma levels of 5 - 6 μSv/h were found, while the radon level does not exceed 200 Bq/m^3. By screening the room above the basement, it is possible to localise the minerals with the highest Ra content. By installing a 5 cm thick lead shield around the most important radiation source (350 kg pechblende) the levels dropped to 1-2 μSv/h in the caretaker's house. This still gives rise to yearly doses of more than 5 mSv. So further action is urgently needed. As the benefit of this minerals is not incontrovertible established, justification has to be considered in order to protect the workers and collectors handling these minerals.

Conclusions and final remarks
All the studied cases in the sectors of concern in the BSS are very different. It is rather diffficult to implement general rules to be followed up. Every case provides another situation or problem. We are trying to make some general guidelines for the control of natural radiation. The stress will be on workplaces where the occupancy is high. Control of the admission in workplaces with high concentrations and low occupancy is also important. If the occupancy is not exactly known it is better to switch over to personal dosimeters instead of environmental surveys.

References

[1] A. Van Deynse, A. Poffijn, J. Buysse, "Radon research among plaster workers and in the phosphate industry", Proceedings of the International Symposium on radiological problems with natural radioactivity in the Non-nuclear Industry, Amsterdam September 1997.

[2] Sutej, Krizman and Ilic, "A new technique for radon measurement based on a combination of a track-etch detector and activated charcoal", Nucl. Tracks Radiat. Meas., Vol 19, Nos 1-4, pp 423-424, 1991.

[3] A. Van Deynse, A. Poffijn, "A personal radon dosimeter based on a combination of a track-etch detector and activated charcoal", Proceedings of the IRPA Regional Symposium on Radiation Protection in Neighbouring Countries of Central Europe 1997, Prague.

[4] A. Van Deynse, A. Poffijn, J. Buysse, P. Cauwels, "A personal radon dosimeter based on the combined charcoal - track-etch technique", to appear in the Proceedings of the 1st Dresden Symposium on Radiation Protection 1998.

[5] ICRP Publication 65, "Protection against radon-222 at home and at work", Annals of the ICRP, Vol. 23, NO 2, 1993.

[6] Task group on lung dynamics; "Deposition and retention models for internal dosimetry of the human respiratory tract"; Health Physics, Vol. 12, pp 173-207, 1966.