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Analysis of the Contribution of Natural Sources of Radiation to the Total Dose Received by Workers

SHORT COMMUNICATION

Carlos SAINZ[1], Ismael FUENTE[1], Luis QUINDÓS[1], Jose Luis GUTIERREZ[1], Jose Luis ARTECHE[2], and Luis Santiago QUINDÓS[1]

[1]RADON Group, University of Cantabria, Santander, Spain
e-mails: sainzc@unican.es, fuentei@unican.es, quindosl@unican.es, gutierjl@unican.es

[2]AEMET, State Meteorological Agency of Spain, Santander, Spain
e-mail: jlag@inm.es

Abstract

People working with ionising radiation are receiving radiation coming from artificial and natural sources. In Spain, as in many other countries, there is a serious control by the national authorities, Spanish Nuclear Safety Council, of the dose the workers receive from artificial sources. However, until the publication of the European Basic Safety Standards Directive, 96/29/EURATOM, the old criteria referring to the "above natural background" were widely used. This directive was incorporated to the Spanish legislation in July 2001 (BOE 178); in its Title VII it recommends to evaluate the dose coming from natural sources and take it into account for establishing the safety criteria. It is noteworthy to assess the natural doses received at homes and the dose received by workers of radioactive installations subject to regulations, and to compare the two results. The social and economical implications of the results derived can be important in the practical application of the recommendations included in the above-mentioned BOE 178 Directive.

Key words: natural radiation, occupational exposure, radon, natural sources of radiation.

1. INTRODUCTION

From the discovery of the existence of ionizing radiation, there have been continuous efforts to use it for mankind benefit. In parallel, the conscience that its use without the due caution can produce harmful effects for the health was born, and also the necessity to adopt protective measures. The human efforts to get to know its benefits and risks has been growing. Along decades, a technical and scientific discipline called radiological protection has developed, which established a complete and coherent system of norms and methods for their application. One of the main characteristics of the radiological protection is the high level of conformity in its application in various countries. This is due to the International Commission of Radiological Protection (ICRP), an independent scientific entity founded in 1928, whose recommendations are followed by the relevant international organizations (IAEA, FAO, ILO, European Union, etc.) and from them by regulations in various countries. The established radiological protection system has contributed to achieving the protection levels that exist today. However, the new technologies and application of radioactive substances, related to the growing use of materials with high content in natural radioactive elements, have led to the necessity of optimization of the radiological protection (European Commission 1999c). This way, the activities relating to the handling of materials with natural radionuclides concern about 85 000 people inside the European Union alone (European Commission 1999a).

As we have indicated, in Spain people that work in the presence of ionizing radiations are subject to a strict protection system that is established in the Regulation for Sanitary Protection against the Ionizing Radiations, BOE 178, which transcribes the basic principles that appear in the European Directive 96/29/EURATOM, and includes Section I, specifically relating to the Natural Sources of Radiation, named Title VII; however, in spite of having gone into effect in the year 2001, it has not yet been applied by the companies which carry out the manipulation of radioactive elements of natural origin. It has been described that people working in these industries receive radiation doses above the legal limits, but they are not subject to radiological control (European Commission 1999b, IAEA 2003).

The dosimetric control situation in Spain for professionally exposed workers is reflected in Table 1. Some of the analyzed radioactive facilities are located in areas of high natural radiation level, leading their workers that live in the environment to receive some very high radiation doses compared to those received during their work with ionizing radiation. If this aspect is not well studied, the conclusion can be drawn that workers of a nuclear power plant receive about 1 mSv/year but those living in the area receive

Table 1

Number of monitored workers and dosimetric results in Spain for the year 2003 (according to Spanish Nuclear Safety Council, CSN)

Number of workers	Mean annual effective dose [mSv]				
	< 2.4	< 5	5-20	20-50	> 50
89 004	52 325	35 362	1255	53	9

a radiation dose of about 20 mSv/year. Evidently, without having more detailed scientific information, any effect on that workers' health will be socially associated to the professional activity at the nuclear power station.

In this context, the aim of the present work is to compare the doses received by workers of nuclear-related activities as a consequence of their habitual work with those that they receive in their daily life in a certain area of our country from natural sources.

2. METHODS

The contribution of natural sources was studied for professionally exposed workers at different institutions like hospitals, nuclear power plants, uranium process industry, research centres and other industries regulated by the Spanish Nuclear Safety Council (Suarez and Fernandez 1997, Quindós *et al.* 1991).

Due to the fact that radon represents more than half of the total dose received by the population from natural sources of radiation, its concentration has been determined yearly by means of CR-39 solid state nuclear track etch detectors (SSNTDs) (George 1996, Nazarof and Nero 1988, European Union 1990). Every CR-39 etched track detector is fastened under the cap of a cylindrical polypropylene container, 55 mm high and 35 mm in diameter, which prevents radon decay products and also ^{220}Rn gas from entering. Then, only alpha particles from radon that has diffused into the container, and from the polonium radioisotopes produced inside can strike the detector. After the exposure time of six months, an etching process is done and radon concentration is determined by counting the alpha tracks in a given area. After collection, the SSNTDs were sent to the Radon Laboratory at the University of Cantabria for processing in a RadoBath etching unit and analyzed in a RadoMeter 2000 unit. From the mean radon concentration expressed in Bq/m^3 and assuming a dose conversion factor for radon exposure of 4 mSv/WLM for an equilibrium factor of 0.4 and an indoor occupancy factor of 0.8 (ICRP 1994, NRC 1999, Miles and Howarth 2000), the annual effective dose was estimated. For a more accurate assessment of the dose from natural radiation exposure, it is necessary to add the contribution due to internal exposure to cosmogenic and primordial radionuclides. The UNSCEAR 2000 Report (UNSCEAR 2000) estimates this contribution at 0.41 mSv/y on average.

3. RESULTS

Table 2 shows a summary of the results obtained for workers in several regulated activities. As can be seen, doses originating from natural sources of radiation have been found to be about one order of magnitude higher than those received from artificial ones. Because some of the studied working activities are located in high natural background areas, some measurements indicate natural radiation doses 20 to 30 times higher than those received from the usual professional activity.

Table 2

Effective doses due to natural and artificial sources of radiation for different workplaces

Workplace	Annual artificial dose [mSv]	Annual natural dose [mSv]
Hospital	0.3 (0.1-5.0)	2.1 (1.8-10.0)
Nuclear power plant	0.2 (0.1-0.5)	6.0 (2.5-15.4)
Uranium proccess	0.6 (0.3-0.8)	5.1 (2.8-16.0)
Research centres	0.4 (0.3-0.6)	4.3 (2.6-6.8)
Other industries	6.1 (0.1-17.5)	2.2 (1.8-2.9)

Note: Values in brackets represent the limits of the range of estimated annual effective doses.

4. CONCLUSIONS

In this work, the contribution of natural sources of radiation to the total dose is discussed, especially when compared with that due to the working activities with artificial sources of radiation. In this way, it is necessary to show the workers with ionizing radiations that the physical characteristics as well as the health impact of ionizing radiations are the same for natural and artificial sources of radiation. The doses originating from natural sources can be sometimes one order of magnitude higher than those received from artificial ones in working activities. Depending on the activity and area of the country, the impact of the natural sources in the total dose can be crucial.

Finally, this study recommends the necessity for including industrial activities which involve materials with high levels of natural radioactivity into the national radiological protection systems.

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