Paper 21

Radiation Exposure at Working places caused by Natural Radionuclides in Germany*

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Preface

The new Euratom basic standards for radiological protection (guideline 96/29/Euratom of the Council of 13 May 1996 on the Determination of Basic Safety Standards for the Protection of Health of Staff and Population against the Dangers by Ionizing Radiation) contain in section 2 of the Title VII, which deals with exposure by natural radiation sources, a request at the EC member states to determine by investigations or other appropriate means the working places which are of importance with regard to natural radiation exposure.

Against the background of the implementation of these new Euratom basic standards, a working group named „Radiation Exposure at Working places by Natural Radionuclides" was founded in November 1994 by the German Commission on Radiological Protection. This working group was supposed to determine

1 the possible exposure paths by natural radiation,
2 the extent of radiation exposure at working places for these exposure paths, and
3 the number of employed persons effected by the different exposure paths

and to compile the gained information in a survey. The following report gives a comprehensive survey on the results of these investigations and their relevance for radiological protection.

The members of the working group who compiled the material and worked out the report were:

Dr. Becker (chairman)	Salzgitter	Dipl.-Ing. Holte	Düsseldorf
Dr. Eder	Munich	Dr. Müller	Dresden
Dr. Frey	Erfurt	Dr. Przyborowski	Berlin
Dr. Hoegl	Erlangen	Dr. Urban	Karlsruhe

Subdivision of Exposure Paths

In the report, exposure at working places is subdivided into the following groups:

1 radiation exposure by natural radionuclides (except radon)
2 radiation exposure by cosmic radiation
3 radiation exposure by radon and its progeny
4 radiation exposure at the removal of uranium mining relics

With regard to the extent of radiation exposure, it was differentiated

1 for the first two groups and for uranium ore mining between:
Exposures with an effective dose of 1 to 6 mSv per year, of > 6 to 20 mSv per year and of > 20 mSv per year as well as

2 in the case of exposures by radon and its progeny in respiratory air:
Between radon concentrations of 1,000 to 3,000 Bq/m^3 and such of > 3,000 Bq/m^3 per year on average. Assuming a balance factor between radon progeny and radon of 0.4, the dose convention of ICRP 65 [ICRP/1/1994] as well as with a working time of 2,000 hours per year, this corresponds to an effective dose of 6 mSv per year (1,000 Bq/m^3) or, respectively, 20 mSv per year (3,000 Bq/m^3).

Summary and Evaluation of the Essential Exposures

* Passed at the 147th Meeting of the German Commission on Radiological Protection on 3rd/4th July 1997

Radiation exposures by natural radionuclides, cosmic radiation and radon also occur without being caused by civilization. In the Federal Republic of Germany, the range of these exposures is between 1 and 6 mSv. Due to the occupational use of natural radioactive substances and to changes in natural living conditions (living in houses, spreading of radioactive substances taken out of the earth´s crust), natural radiation can change to higher or lower exposures.

The transition between natural and civilization-caused exposures from natural radiation sources is fluid and cannot be influenced (areas with increased radon deposits). Therefore, it seems to be reasonable to examine in particular the exposures of > 6 mSv per year. IAEA recommends that radon concentrations up to approximately 1,000 Bq/m^3 at working places be not considered. This corresponds to an effective dose of 6 mSv per year.

In the following table, the essential radiation exposures at working places by natural radionuclides with more than 6 mSv per year are given. According to ICRP 65, the annual stay due to occupation of 2,000 hours in a radon atmosphere of 1,000 - 3,000 Bq/m^3 was equated with an effective dose of 6 - 20 mSv per year.

Exposure	Number of occupied persons with annual doses of (estimated values)	
	> 6 mSv to 20 mSv	> 20 mSv
Phosphate processing	---	---
Coal residues	---	---
Thoriated welding electrodes	5,000	---
Thorium mantles	some	---
Minerals	---	---
Flying personnel	some hundreds[1]	---
Frequent flyers	some hundreds[1]	---
Coal mining	some hundreds	---
Working places in buildings	50,000	10,000
Water supply and distribution[2]	2,000	300
Sewers	individual cases	---
Balneology	individual cases	---
Underground (without uranium ore mining and coal mining)	1,000	200
Uranium mining	230	---

(---) means that no radiation exposure is to be expected in this exposure group with the relevant exposure path.

Many radiation exposures by natural radiation sources only occur at working places which require monitoring in the sense of conventional maintenance of industrial health and safety standards. By conventional measures concerning health and safety at work, e. g. suction devices during welding and grinding or higher ventilation rates, these exposures can considerably be reduced.

Considering both arguments - threshold at 6 mSv per year and use of conventional measures concerning health and safety at work, only few radiation exposures by natural radiation sources at working places remain to be examined for reasons of radiological protection:

1 Use of thoriated welding electrodes

[1] Number when there is low sun activity

[2] Specific durations of stay have been considered to a wide extent

2 Flying personnel and persons flying frequently due to their occupation
3 Working places in water supply and distribution
4 Working places in the removal of uranium mining relics
5 Underground working places
6 Working places in buildings with increased radon concentration.

According to this, approximately 10,000 persons are in the group of persons exposed to natural radiation at working places with effective doses above 20 mSv per year. Approximately 50,000 persons receive effective doses of more than 6 mSv to 20 mSv per year.

Number and extent of exposures at working places in buildings with high radon concentrations require further clarifications, which should be gained in the corresponding processing in residential buildings.

Compared with other working places with increased radon concentrations (e. g. working places underground), working places with increased radon concentrations in buildings show a number of exceptional features which must be taken into account in the discussion on the question whether they should be included in occupational radiological protection:

1 The risk coefficient for the increase of the lung cancer rate by radon/radon progeny exposure has been derived up to now only on the basis of epidemiological mining worker studies - exposure underground - and has been transmitted to the population - exposure in the living area. Hopefully, this world-wide summary of the results from the current epidemiological studies for the population will tell whether this procedure has been justified.
2 It is known in which areas there is an increased possibility that increased radon concentrations in buildings may occur. It cannot be predicted, however, which single working place may be concerned. To identify working places affected, many working places in buildings ought to be examined in the areas with increased radon occurrence. In Germany, investigations have been carried out to identify such areas with increased radon occurrence.