2012

RAD

The First International Conference on Radiation and Dosimetry in Various Fields of Research

APRIL 25 - 27, 2012
FACULTY OF ELECTRONIC ENGINEERING | NIŠ | SERBIA

PROCEEDINGS

MMXII

PUBLISHER: University of Niš, Faculty of Electronic Engineering
P.O.Box 73, 18000 Niš, Serbia
www.elfak.ni.ac.rs

FOR THE PUBLISHER: Prof. Dr. Zoran Perić

EDITOR: Prof. Dr. Goran Ristić

COVER DESIGN: Vladan Nikolić, arch.

TECHNICAL EDITING: Vladan Nikolić, arch.

PROOF-READING: Saša Trenčić, BA

PRINTED BY: Medivest, Niš

PRINT RUN: 200 copies

The First International Conference on Radiation and Dosimetry
is realized as a part of the FP7 project: Joint research on various types
of radiation dosimeters (RADDOS)

ISBN 978-86-6125-063-7

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FOLLOW-UP OF Cs-137 ACTIVITY IN THE FIRST 100 AIR SAMPLES IN THE AREA OF KUMODRAZ, BELGRADE IN THE 2009 TO 2011 PERIOD

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Abstract. *This paper presents results of gamma spectrometric analyses of air samples, collected in the period from 2009 to 2011, at Kumodraz location. Cs-137 specific activity has been monitored for 4 years. Exposure rate of gamma background radiation has been showed, as well. Obtained results show that average annual effective doses are in the range from 1.01 to 1.19 mSv/y and lower than the worldwide average.*

Key words: *gamma spectrometry, Cs-137, background radiation, monitoring, dose*

1. INTRODUCTION

Men are continuously exposed to radiation originating from natural and artificial radionuclides. Systematic measurements of radioactivity of air samples are important precondition for timely reactions in the event of increased exposure of population to radiation. Presence of anthropogenic radionuclides in the air is one of the main nuclear accident occurrence indicators.

Cs-137 is a fission product released into atmosphere in the course of nuclear weapon testing or during radiation accident in nuclear power plants. Very small amount of Cs-137 is released from nuclear power plants as radioactive waste. As a part of aerosol, Cs-137 is released from the atmosphere to reach soil through precipitation, atmospheric washout or direct deposition due to gravitational forces. Caesium is chemically highly reactive. Due to its chemical nature and relatively long half-life period (30.17 years), Cs-137 has low mobility in natural environment and represents a hazard for the biosphere. It can easily form real solutions, but its total concentration in surface waters is low due to sorption in continental clay minerals. [1].

The amount introduced into organism by inhalation and ingestion is very important, since it metabolically behaves like K or Ru and is distributed almost in a uniform manner throughout soft tissues, particularly muscles. Caesium reaches the systemic circulation through respiratory and digestive organs and is almost completely absorbed in blood. Its biological half-life is 20 to 140 days, depending on the organism mass.

As a part of monitoring, daily control of fon levels in the territory of the city is highly important, as it is the earliest indicator of increased radiation activity. The goal of the paper is to present the results of the systematic monitoring of Cs content in aerosol and the level of gamma radiation exposition dosage as an indicator of natural fon at the location of Kumodraz, Belgrade, and their comparison with the world average values as well [2, 3].

2. MEASUREMENT METHODOLOGY

The DH-604EV.2 digital sampler manufactured by F&J SPECIALTY PRODUCTS, INC. was used for air sampling. Air samples were taken at the 124 cm altitude, above non-cultivated surface. Air was sucked through cellulose filter paper FJ213340, with 1.770 mm thickness and 65% filtration efficiency achieved in appropriate testing. The amount of air that was sucked through the filter ranged from 5,000 m3 to 10,000 m3, and the temperature varied in intervals characteristic for seasons in a 3-year period, with usual fluctuations of day and night temperatures. The filter paper with the 10.2 cm radius with aerosol samples was measured directly and analysed by gamma spectrometric method.

Aerosol samples were measured by HPGe detectors of high purity and with 50% relative efficiency at energy level of 133 keV. Energy calibration and detector efficiency calibration were performed using radioactive standard in a 1000 ml marinelli-type vessel, obtained by titrating radioactive solution with Am-241, Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Sr-85, Cs-137, Y-88 and Co-60 onto a circular filter paper in a hexagonal grid. Duration of measurement was 250 000 s.

Strength of the absorbed gamma radiation dose was measured by means of a PC-RM gamma radiation monitor, that is, detection probe (GM counter ZP1400 Philips) which is its integral part. Sensitivity of this detector is 2.7 s-1/μGy·h-1 for Co-60. Main function of the monitor is to visualize the strength of gamma radiation exposition dose in the surrounding environment using a simple graphical interface, and to

alarm the user in the event that the measured value exceeds a certain limit, indicating increased level of exposure. The results are automatically recorded and archived along with the data on the recording time. This device is able to operate using preset time of measurement or, if precision is required, with preset statistical error. When working with the preset time of measurement, the results of individual one-second measurements in such time interval are averaged.

3. RESULTS AND DISCUSSION

Figure 1 shows the results of measurement of Cs-137 specific activity in air samples in the October 2008 – December 2011 period in Kumodraz. Measurement also covers March 2011 when the accident occurred in the Fukushima power plant in Japan. Small increase of Cs-137 activity was registered in the mentioned period, in accordance with the results of other institutions engaged in similar issue [4,5,6]. Gamma spectrometric analysis showed that Cs-137 specific activity values ranged within 0,2 to 2,2 μBq/m3 limits, and presented no significant change which could indicate more significant population radiation load in this part of Belgrade. In March and April 2011, Cs concentration ranged up to 0.09 mBq/ m3, and its monthly average level reached 0.022 mBq/ m3. These results are several times lower than the results of measurement during Chernobyl event, due to large distance from Fukushima and dilution effects [7, 8].

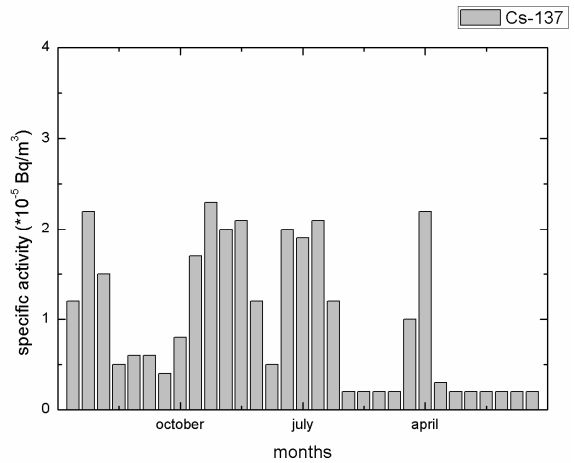

Fig. 1: Graphical presentation of Cs-137 concentration in air, in the 2008-2011 period in Kumodraz.

Figure 2 shows the results of the effective dose strength in the 2008-2011 period in Kumodraz. Monthly levels of the effective dose strengths were obtained by averaging the results of daily measured doses.

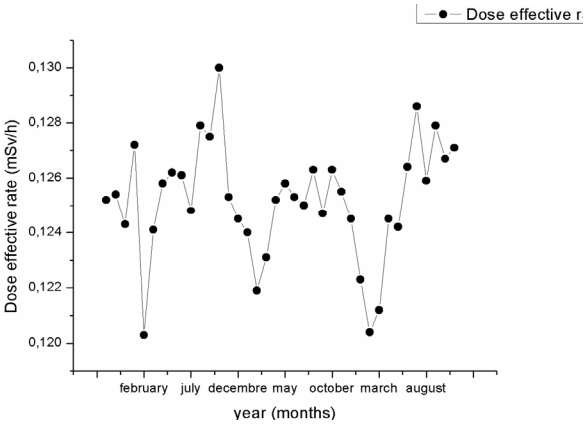

Fig. 2: Graphical presentation of the effective dose strength variation in the four-year period.

Annual effective doses for the same period are shown in Table 1. Average annual effective doses were calculated using the following equation:

$$E(y) = \overline{E}(y) \cdot t \qquad (1)$$

It is obvious that the effective dose strength varied within a narrow value interval, with usual seasonal variations concordant with meteorological conditions. Annual effective doses for the same period are shown in Table 1.

Exposure of Kumodraz population to radiation was in accordance with the values prescribed by the Law on Ionizing Radiation Protection. Average annual values of effective radiation doses on a world level amount to 1-10 mSv, with mean value of 2.4 mSv [9, 10]. It can be observed that annual effective radiation doses measured in Kumodraz are significantly lower than the world average.

Table 1: Annual effective doses in the 2008 – 2011 period

Annual effective dose (mSv/y)	Year
1,092	2008
1,102	2009
1,093	2010
1,095	2011

4. CONCLUSION

Radionuclide pollution of biosphere was mostly contributed by atmospheric nuclear explosions. Sedimentation of radionuclides from the atmosphere represents a significant source of global contamination of the environment. The environmental image of radioactive Cs-137 circling was significantly altered as opposed to the stable isotope. If geographic origin influence is taken into account, it can be concluded that the values obtained in this paper are compliant with the reference values set by international organizations engaged in ionizing radiation protection issues.

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