XA0054238

IAEA-CN-78/42

RADIOACTIVITY STUDIES IN THE ROMANIAN NATIONAL REPOSITORY FOR RADIOACTIVE WASTE – BAITA, BIHOR REGION, DURING 14 YEARS OF RESOURCE DEVELOPMENT

F. DRAGOLICI, G. ROTARESCU, A. LUCA, T. PEIC, C. POSTELNICU, A.C. DRAGOLICI,
Institute of Research and Development for Physics and Nuclear Engineering
"Horia Hulubei", R-76900, P. O. Box MG – 6, Bucharest – Magurele,
Romania

Abstract

The main objective of the study is focused on active surveillance, by periodic measurements of the radioactivity and the possible migration, during the last 14 years, of the radioactive elements stored at the Romanian National Repository for Radioactive Waste-Baita, Bihor region. Hence, water, soil and vegetation samples were collected every three months, from 57 points, chosen in agreement with the National Commission for Nuclear Activities Control and with the local Public Health Institutions. After the sample collection, radiometric measurements were made. The main steps of the study were: the collection of the samples, radiometric measurements, radiochemical analysis of the uranium and progeny, processing and the interpretation of the obtained data; detection of any gamma radionuclides using gamma spectrometry; and the processing, interpretation and intercomparison of the results. Throughout the 14 years of surveillance, it was demonstrated that the National Repository for Radioactive Waste activity has had no negative impact on the operator staff, environment and population. Also, no migration of the deposited radionuclides was detected throughout the whole area.

1. *INTRODUCTION*

The utilization of nuclear techniques and technologies in socio-economic activities, besides beneficial applications, results in the generation of wastes, which because of toxicity and the radioactivity level, are included in the radioactive waste category. The potential danger represented by the radioactive wastes becomes real only if they reach in biosphere. That is why, they been planned and designated, in the context of resource development facilities, for final disposal as radioactive waste. Such a facility is The National Repository for Low and Intermediate Radioactive Waste, built in Baita - Bihor region, in a terminated uranium mine.

The repository is situated in two galleries which intersect: Gallery 50, with entry at 838,9 m level depth and 885 m in length and Gallery 53 with entry at 837,4 m level depth and 374 m in length. From a geological point of view, the site is 840 m above sea level and the host rock is crystalline with a low porosity, good chemical homogeneity and impermeability, maintaining these characteristics over a considerable horizontal and vertical span. In compliance with the International Atomic Energy Agency (IAEA) recommendations and with the National Commission for Nuclear Activities Control (CNCAN) objectives, the protection area surrounding the radioactive waste repositories and the transport roadways, must be monitored for radiological contamination during the entire working period of the repository, as well as during the institutional control period (100 – 300 years). Migration of radionuclides from the radioactive waste repositories can take place in the case of a natural catastrophe or resulting from water infiltration into the repository. This infiltration can induce thermal flux from radionuclides in the drums permanently deposited therein, thus causing migration into the environment. In order to forestall such incidents, it is necessary to establish a methodology for the constant monitoring for water, soil, vegetation contamination and external gamma irradiation in the radioactive waste repository areas. This study presents the methodology used by the National Institute of R&D for Physics and Nuclear Engineering "Horia Hulubei" – Bucharest, Magurele, for the dynamic surveillance of the Baita Repository area, throughout the 14 years of operation.

2. EXPERIMENTAL PART

Taking into consideration the fact that most of the deposited radionuclides produce gamma radiation, methods were developed to identify it; specifically gamma spectrometry. Radiometric methods were used to determine the influence of the deposited radionuclides in the environment. So, the main steps and objectives consist of: the collection of the samples, radiometric measurements, radiochemical analysis of the uranium and progeny, the processing and the interpretation of the collected; the detection of any gamma radionuclides using gamma spectrometry; the processing, interpretation and intercomparison of the results. In order to have complete characterization of repository activity and of the transport pathways, 33 sample collection were established. These points were approved by the local Sanitation Authority and the National Commission for Nuclear Activities Control. Since 1996, the Radionuclide Metrology Laboratory from NIPNE-HH has been performing gamma spectrometry analyses. The Romanian Bureau of Legal Metrology (BRML) authorizes this laboratory for radioactivity measurements.

3. RESULTS

The radiometric measurements were done in two area of interests: the transport route Stei Railroad Station – Reception: Expedition Station (RES) – National Repository of Radioactive Waste (presented in Table I), and within a 50-m radius around the repository. The radiochemical measurements were done on water, soil and vegetation samples. The annual averages of Ra-226, Th-232 and U-238 radionuclides concentrations in water in four selected points are presented in Table II [3]. The gamma spectrometry equipment is composed of a Ge(Li) semiconductor-detector (6% relative efficiency) [3], a high voltage power supply (FAN 1137), a charge preamplifier (FAN 1141), a spectrometric amplifier (CANBERRA 2021) and a multichannel analyzer (CANBERRA 8604A). The detector is surrounded by 5cm thick lead shield. The integral gamma background (50-1700keV) is set to 5 cps (counts per second). Each sample is placed on top of the detector and measured. The usual count times are 3600s (for soil) and 5000s (for vegetation and water). The energy and efficiency calibrations are performed using point standard sources of Eu-152 [2]. This radionuclide was preferred because its most important gamma emissions cover a wide range of energy: 121.8 – 1408.0 keV. The calibration procedure takes into account the geometrical characteristics and the density of each sample.

4. CONCLUSIONS

The comparative study on the data obtained after the radiometric, radiochemical and spectrometric analysis from 1984 to 1998, indicated no modification of the radiological state of the area, as a result of the radioactive waste disposal activity. Tritium levels established using liquid scintillator spectrometry has comparable values with those measured in the previous years. No migration of the deposited radionuclides was detected. Values of the Cs-137 and Co-60 were well below the permissible limits. The radiometric measurements of the external gamma irradiation level and the radiochemical analysis on the water, soil and vegetation samples prove that the repository activity reveals no additional radiation risk for the population and the environment.

References

[1] "Low level gamma-spectrometry by beta coincidence", E. L. Grigorescu, Nucl. Instr. and Meth., A 369, 574, 1996.

[2] "National Comparison of environmental sample activity measurement", M.Sahagia, E.L.Grigorescu, C. C. Popescu, A. C. Razdolescu, Nucl. Instr. and Meth, A 339, 38, 1994.

[3] "Rn-222 gaseous standard sources, produced in IFIN-HH", A. Luca, D. Stanga, E. L. Grigorescu, 3rd General Conference at the Balkan Physical Union (BPU-3), Cluj-Napoca, Romania, 1997.

TABLE I. RESULTS OF THE RADIOMETRIC MEASUREMENTS ON STEI RAILROAD STATION- RECEPTION: EXPEDITION STATION-NNRW ROUTE. MEDIUM ANNUAL VALUES OF THE DOSE EQUIVALENT FOR 1984-1998 PERIOD.

Nr. crt.	Place of measurement	EQUIVALENT DOSE (micro Sv/h)															
		1984	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	ICIM Measure	84-98 Media
1.	Stei Railway Station-RES route–**Average 1**	**0.13**	**0.19**	**0.15**	**0.17**	-	**0.13**	-	-	-	-	0.16	0.11	0.16	0.11	-	**0.14**
2.	Stei-intersection bus road	0.07	0.07	0.14	0.15	0.11	0.12	0.11	0.22	0.24	0.10	0.09	0.12	0.12	0.08	0.16	0.12
3.	Gym	0.08	0.08	0.13	0.10	0.12	0.08	0.11	0.12	0.12	0.15	0.08	0.07	0.16	0.08	0.15	0.10
4.	Bridge	0.07	0.07	0.14	0.13	0.10	0.07	0.10	0.09	0.12	0.10	0.08	0.07	0.08	0.07	0.17	0.09
5.	Gateway	0.08	0.08	0.15	0.17	0.13	0.13	0.12	0.25	0.25	0.17	0.15	0.13	0.14	0.10	0.58	0.14
6.	Gas Station	0.07	0.09	0.14	0.14	0.10	0.10	0.10	0.11	0.11	0.15	0.09	0.08	0.10	0.10	0.20	0.10
7.	Fire Brigade	0.08	0.14	0.14	0.13	0.12	0.10	0.10	0.13	0.12	0.16	0.12	0.08	0.10	0.09	0.14	0.11
8.	Lunca – store	0.08	0.07	0.14	0.12	0.11	0.10	0.15	0.16	0.15	0.07	0.09	0.10	0.09	0.08	0.17	0.10
9.	Harsesti – bus station	0.08	0.04	0.17	0.15	0.14	0.10	4.50	0.13	0.12	0.07	0.13	0.08	0.09	0.10	0.20	0.37
10.	Lunca – nursery	0.10	0.09	0.15	0.15	0.14	0.13	0.25	0.90	0.85	0.07	0.10	0.11	0.11	0.09	0.20	0.25
11.	Campani- Baita bridge	0.12	0.13	0.17	0.13	0.12	0.10	0.15	0.11	0.12	0.10	0.09	0.08	0.08	0.09	0.16	0.11
12.	- curve stand out	0.12	0.12	0.16	0.15	0.13	0.13	0.15	1.00	1.10	0.30	0.15	0.11	0.11	0.10	0.15	0.27
13.	- bus station	0.12	0.11	0.14	0.16	0.14	0.13	0.12	0.15	0.14	0.12	0.17	0.10	0.10	0.11	0.19	0.12
14.	- Sighistel	0.10	0.09	0.15	0.16	0.13	0.14	0.12	0.13	0.13	0.12	0.12	0.11	0.10	0.10	0.22	0.12
15.	Fanate – bus station	0.10	0.09	0.15	0.13	0.13	0.12	0.09	0.12	0.12	0.13	0.25	0.11	0.11	0.09	0.23	0.12
16.	Nucet -	0.10	0.09	0.20	0.22	0.13	0.16	0.17	0.15	0.16	0.12	0.14	0.40	0.11	0.11	0.21	0.16
17.	- gallery	0.10	0.11	0.16	0.18	0.20	0.16	1.50	0.19	0.19	0.14	0.18	0.13	0.17	0.12	0.28	0.25
18.	- bus station	0.10	0.12	0.10	0.12	0.12	0.12	0.30	0.14	0.12	0.12	0.10	0.10	0.16	0.09	0.21	0.12
19.	Entry Baita village	0.10	0.09	0.18	0.20	0.13	0.12	1.50	0.20	0.21	0.14	0.25	0.12	0.12	0.11	0.22	0.15
20.	Baita-bus station	0.15	0.10	0.23	0.20	0.13	0.14	0.25	0.15	0.14	0.35	0.25	0.24	0.45	0.11	0.24	0.28
	Average 2	**0.09**	**0.09**	**0.15**	**0.14**	**0.12**	**0.11**	**0.19**	**0.24**	**0.23**	**0.14**	**0.13**	**0.13**	**0.13**	**0.09**	**0.21**	**0.16**
21.	Baita-Arieseni intersection	0.30	0.15	0.24	0.20	0.15	0.16	0.19	0.19	0.19	0.21	0.22	0.25	0.14	0.12	0.24	0.19
22.	Baita Plai Repository	0.15	0.28	0.25	0.30	0.30	0.16	0.30	0.42	0.46	0.60	0.30	0.22	0.38	0.12	0.31	0.30
23.	Baita Plai – Molibden	0.30	0.17	0.26	0.22	0.28	0.25	0.20	0.42	0.48	0.68	0.42	0.33	0.16	0.15	0.48	0.31
24.	- bus station	0.15	0.35	0.70	0.44	0.40	0.42	0.30	0.50	0.35	0.52	0.72	0.40	0.48	0.20	-	0.42
25.	- canteen	0.15	0.16	0.27	0.30	0.28	0.26	0.14	1.00	2.50	1.50	0.37	0.28	0.45	0.25	0.75	0.56
26.	- barrier	0.80	0.85	0.52	0.42	0.40	0.30	0.60	0.85	1.25	1.10	1.02	0.47	0.65	0.60	0.70	0.70
	Average 3	**0.31**	**0.32**	**0.37**	**0.31**	**0.30**	**0.25**	**0.28**	**0.56**	**0.87**	**0.76**	0.50	0.32	0.37	0.24	**0.49**	**0.41**

TABLE II. RESULTS OF THE RADIOCHEMICAL MEASUREMENTS. ANNUAL AVERAGE OF THE RA-226, U-238, TH-232 NATURAL RADIONUCLIDES CONCENTRATION IN WATER FOR 1986-1998 PERIOD. MDA = MINIMUM DETECTABLE ACTIVITIES.

YEAR	RADIONUCLIDES CONCENTRATIONS (Bq / l)											
	Ra - 226				U - 238				Th - 232			
	Point 1	point 2	point 3	point 4	point 1	point 2	point 3	point 4	point 1	point 2	point 3	point 4
1986	0.134	0.021	0.095	0.018	2.475	2.366	2.787	1.273	0.009	0.009	0.014	0.014
1987	0.088	0.073	0.014	0.012	4.592	1.943	0.512	0.239	0.036	0.028	0.032	0.033
1988	0.009	0.012	0.016	0.010	4.244	1.885	1.046	1.018	0.019	0.009	0.013	0.010
1989	0.007	0.067	0.027	0.047	4.122	1.887	2.076	0.283	0.033	0.028	0.024	0.077
1990	0.055	0.104	0.088	0.094	0.705	1.138	0.479	0.404	0.111	0.011	0.029	0.009
1991	0.055	0.104	0.100	0.086	0.956	0.489	0.633	0.307	0.008	0.010	0.021	0.008
1992	0.025	0.037	0.014	0.009	0.936	0.722	0.892	0.583	0.730	0.016	0.016	0.32
1993	0.038	0.035	0.028	0.042	0.372	0.494	0.430	0.358	0.032	0.037	0.029	0.034
1994	0.099	0.025	0.013	0.005	0.273	0.445	0.285	0.052	0.022	0.016	0.032	0.015
1995	0.031	0.313	0.012	0.006	0.245	0.218	0.096	0.052	0.020	0.037	0.015	0.012
1996	2.275	2.275	2.150	2.550	23.50	24.50	1.750	24.50	-	0.016	-	-
1997	0.004	0.007	0.005	0.006	MDA	MDA	MDA	MDA	MDA	0.017	MDA	MDA
1998	MDA	MDA	MDA	MDA	MDA	MDA	MDA	MDA	MDA	MDA	MDA	MDA
AVERAGE	**0.235**	**0.256**	**0.213**	**0.240**	**3.856**	**3.235**	**0.835**	**0.024**	**0.102**	**0.018**	**0.022**	**0.024**

TABLE III. RESULTS OF THE SPECTROMETRIC MEASUREMENTS WITH LIQUID SCINTILLATORS ON WATER SAMPLES IN 1986-1998 PERIOD.

YEAR	H – 3 CONCENTRATION (Bq/l)				YEAR	H – 3 CONCENTRATION (Bq/l)			
	Point 1	Point 2	Point 3	Point 4		Point 1	Point 2	Point 3	Point 4
1986	41.282	13.120	18.755	10.080	**1993**	168.200	35.280	6.960	7.250
1987	34.895	56.485	56.112	29.430	**1994**	148.150	77.725	7.415	2.945
1988	186.177	29.115	30.075	41.245	**1995**	119.540	72.970	6.850	5.250
1989	116.855	39.383	22.520	33.442	**1996**	258.250	14.675	8.575	16.300
1990	78.611	14.720	9.120	9.760	**1997**	-	-	-	-
1991	104.280	14.950	8.880	10.280	**1998**	225.750	10.900	4.600	4.425
1992	276.120	34.980	5.060	5.480	**Average**	**146.522**	**34.525**	**15.410**	**14.657**

TABLE IV. RESULTS OF THE SPECTROMETRIC MEASUREMENTS ON SOIL SAMPLES.

RADIONUCLIDE	Point	Radionuclide concentration (Bq/g)				RADIONUCLIDE	Point	Radionuclide concentration (Bq/g)			
Co – 60		1989	1996	1997	1998	Cs - 137		1989	1996	1997	1998
	1	-	0.021	MDA	-		1	0.065	0.341	0.463	-
	2	-	0.022	MDA	MDA		2	0.426	0.087	0.224	0.154
	3	-	0.033	MDA	MDA		3	0.564	0.402	0.203	0.292
	4	-	0.017	MDA	MDA		4	0.532	0.173	0.265	0.258
	5	-	0.026	MDA	MDA		5	0.349	0.144	0.185	MDA
	6	-	0.807	1.064	MDA		6	0.459	0.324	0.561	-
	7	-	0.018	MDA	MDA		7	0.373	0.017	0.128	0.120
	8	-	0.024	MDA	MDA		8	0.327	0.095	0.165	0.240