OSCE Radiological Fact Finding Mission
Metallurgical Plant, JSCC "Moldova Steel Works"
Rybnitsa

Transdniestrian Region, Moldova

1 to 4 December 2003

Experts

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INTRODUCTION

A fact-finding mission organized by OSCE was carried out to assess the radiological situation in JSCC "Moldova Steel Works", in Rybnitsa, Transdniestrian Region of Moldova. The reason for the assessment was that radioactive sources containing ^{60}Co and ^{137}Cs were melted at the metallurgical plant three times in the last three years. In view of its competence in radiation and source safety, the Agency was requested by OSCE to provide experts to participate in the fact-finding mission.

Upon arrival to Chisinau, the capital city of Moldova, a formal meeting with representatives of the Moldavian Government took place at the Headquarters of the OSCE Mission in Moldova. The OSCE officials provided information on the purpose and scope of the mission and the status of the Agency experts. It was explained that the Agency experts would provide their report to OSCE only and it would decide about further distribution of the report.

Another formal meeting was held in Tyraspol, the capital city of Transdniestrian Region, where the same information was given to the Transdniestrian authorities. It was agreed that representatives of the Transdniestrian authorities would accompany the mission team as observers.

At the metallurgical plant in the city of Rybnitsa, located about 100 km north from Tyraspol, the plant management provided the following information to the mission team:

- The plant layout and technological processes;
- A description of the source melting events and actions to mitigate the consequences including the safe handling and storage of contaminated material; and
- The plant's radiation protection system, including procedures for personnel monitoring and protection, as well as applied methods, laboratories and equipment to detect radioactive material in the scrap metal, in the products and by-products.

The mission team was guided through the plant's production lines and storage area where the contaminated steel products and by-products (dust and slag) produced during the source melting events were stored. Besides the on-site measurements using hand-held equipment, the experts collected samples from the contaminated materials and all key places where contamination was expected, including internal roads and the transport entrance of the plant. The samples were transferred to the Agency laboratory in Seibersdorf for detailed analysis.

The present report describes the actions taken and the results obtained from the monitoring work and assessment carried out for the purpose of fulfilling the objectives of the mission.

MEASUREMENTS

To establish the radiological situation a survey plan was prepared based on the information provided by the Plant management during the meetings and site visits.

The plan consisted in dose rate measurements and swipe testing for contamination on surfaces to map the radiation pattern at the Plant facilities. The survey, that included soil and dust sampling for later contamination evaluation was carried out at different key places based upon the information gathered on the movement of the contaminated material and by the results from on-going radiation measurements performed as planned. Radiation measurements for dose rate levels, surface contamination and emitter nuclide identification were performed using portable instruments, GM detectors, gamma spectrometer based nuclide identifier, and end-window GM for beta-gamma contamination. The samples from dust and soil were also to be used to confirm the contaminating radionuclides and to search for the presence of other, non-gamma emitting nuclides or when activities were extremely weak to be detected with field instruments.

Two radically different contamination situations had to be taken into account, one for the melting of a ^{60}Co source in which case most of the radioactive substance is held within the melted scrap resulting in contaminated metal end products. The other was the case of ^{137}Cs

source melting in which case most radioactive material is evaporated at the melting temperatures and transfer with the dust resulting from the scrap melting process.

For the first case, radiation and contamination measurements were taken in the store where the end-products were kept under controlled condition. Radiation levels were also checked in the surroundings of the storage building.

For the second case, radiation measurements and sampling were done following the route used for the transport and disposal of the contaminated dust, carried by truck from the loading boxes at the dust collectors (steam/dust/gas scrubbing system) to the storage yard at the end of the Plant premises and from there to the containers for storage.

Surveys were also done close to the concrete fence at the perimeter of the temporary waste storage facility where contaminated dust from the first ^{137}Cs source melting event during August 2000 was stored, Figures 2,3 and 4.

Samples were taken from three tanks for dust storage Figures 5, 6 and 7, at the dust piles yard Figures 8 and 9, on the internal roads at the crossing identified between buildings number 64 and 65 as indicated in the Plant layout, at the Plant vehicles access gate 58 and in the cabin of one of the trucks used to transport dust from the bunkers to the dust yard Figure 10. From Scoria store small pebbles were taken for analysis.

Outside the plant soil samples were taken from sidewalks at the plant site and from the field at some 15 km from the Dniester river by the road in direction to Chisinau, Figure 11.

All swipes and samples were transferred upon arrival back to Vienna to the IAEA chemistry and physical laboratories at Seibersdorf for their radioisotope content analysis.

RESULTS

Radiation levels in the range of background were currently found throughout the premises of the Plant with the exception of those places where considerable amount of contaminated dust was kept and where in all measurement instances ^{137}Cs was identified as sole radiation emitter contributor. No trace of radiation from ^{60}Co contamination was detected anywhere but in the steel end-products. Dose rates of up to 0.4 microSv/h were measured at the entrance at the open dust yard. At the cordoned line to restrict access to dust containers, the dose rates ranged from 0.240 microSv/h to 0.360 microSv/h. At close distance from the temporary disposal facility for ^{137}Cs contaminated dust dose rate levels of approximately 0.200 microSv/h were found.

No measurable radiation from ^{60}Co was detected in the surroundings of the storage building where the contaminated end-products were stored. Inside the store dose rates were in the range of 0.2 microSv/h near the entrance.

Finally a road survey was done with a high sensitive scintillator based detector touring the internal roads of the plant on a car at low speed. No relevant signal of radiation above background was detected.

Table 1 shows results of activity measurements from swipes, Table 2 gives results for soil, dust and scoria samples

Table 1: Activity measurement on swipes

No	Sample ID Code	Swipe Sampling Place	Total Activity per swipe

1	S-1	On floor surface at North corner of disposal facility wall	<LOD
2	S-2	Same as 1 at the South corner	<LOD
3	S-3	Surface end-product piece in storage	<LOD
4	S-4	Surface end-product piece in storage	<LOD
5	S-5	Surface end-product piece in storage	<LOD
6	S-6	Plant access gate	<LOD
7	S-T1	Truck cabin, drive wheel and dials panel	<LOD
8	S-T2	Truck cabin, pedals	<LOD

Limit of Detection (LOD)<0.3 Bq

Table 2: Activity results from dust and soil samples

No	Sample ID Code	Sample type	Sampling Place	^{137}Cs Activity Concentration Bq/kg
1	SA-1	Dust	Loading box floor Bunker collector 1	10273
2	SA-2	Dust	Loading box floor Bunker collector 2	992
3	SA-3	Dust	Loading box floor Bunker collectors 3	853
4	SA-7	Dust	Container tank # 10	116700
5	SA-8	Dust	Container tank # 7	100700
6	SA-9	Dust	Container tank # 12	134300
7	SA-10	Dust	Piles in open yard	91
8	SA-11	Dust	Piles in open yard	312
9	SA-12	Dust	Piles in open yard	191
10	SA-13	Dust	Piles in open yard	454
11	SA-14	Dust	Access to open yard	2978
12	SA-15	Soil	Plant access gate	96

13	SA-16	Soil	Country field by the road	8
14	SA-17	Soil	Street corner in the plant	128
15	SA-18	Soil	Plant perimeter sidewalk	12
16	Sc-1	Pebbles	Scoria storage building	13
17	Sc-2	Pebbles	Scoria storage building	8

ANALYSIS

1. Based on the on-site measurements

The measured dose rate values show levels in the range of background except at the dust piles in the open yard and close to the containers with contaminated dust where dose rates were up to several times higher than background.

Only ^{137}Cs was identified as the only contributor to the dust contamination, confirming that ^{60}Co had been practically retained in the metal product from the scrap melting.

No ^{137}Cs or ^{60}Co contamination was found from swipe testing taken at the indicated places.

2. Based on laboratory analysis of samples

From laboratory analysis by gamma spectrometry it was again confirmed that ^{137}Cs is the only source of radiation in the dust and soil samples. No trace of ^{60}Co above detection limit was found in the samples.

No other radionuclides were found

No contamination was found at internal roads. Substantial residual contamination was only found at the dust storage area.

Results from the two samples taken outside the Plant showed no detectable quantity from ^{137}Cs or ^{60}Co above background

The detailed description of the methodologies used for laboratory measurement and analysis of the results is included in Annex.

CONCLUSIONS AND RECOMMENDATIONS

From the results achieved and the assessment of the plant radiological situation some general observations and conclusions can be made as follows:

- No exposure hazard to operational personnel exists at the operational plant installations
- Because of some residual contamination at the open yard, access should be restricted to authorized persons. It is recommended that remedial actions to reduce contamination be carried out.
- Clean up of the dust collectors boxes shall be undertaken to further reduce contamination levels.
- The results from the measures of samples taken at the side walk by the Metallurgical plant in Ribnitsia and at some 15 km from the Dniester river in direction to Chisinau should be taken cautiously, as test only and not as an environmental analysis. It is nevertheless recommended that the environmental monitoring is continued.
- It is unlikely that any exposure of members of the general public has to be considered as a result of the source melting events at the Plant
- The melted sources are suspected to be industrial gauges falling in Category 3, according to IAEA-TEC-DOC-1344.
- Based on the on-site measurements carried out by portable gamma spectrometer and preliminary results from sample assays performed at the Agency laboratory the presence of ^{137}Cs is confirmed, the measured dose rates indicate low contamination, except near to the containers filled with contaminated dust;

- No contamination from ^{60}Co was detected on the site and in the samples; the plant staff confirmed that according to their measurements ^{60}Co appeared only in the steel product confined in a storage building;

- The waste storage facility constructed after the first and second incidents as well as the work carried out to clean up the site and build a new store for the waste resulting from the latest melting event was appropriate;

- The plant has an acceptable radiation protection infrastructure including a limited number of competent staff and acceptably maintained and calibrated equipment for detection and measurements;

- The plant management demonstrated good knowledge of radiation hazards and showed commitment to radiation safety and protection as condition for their normal business;

- Modern portal monitors are in place to control scrap cargos but they are not sufficient to detect radiation sources entering in the scrap yard and later into the furnace;

- Radiation safety authorities controlling practices and environmental protection are in place but their inspection capabilities are limited due to lack of sufficient staff and equipment.

If the OSCE proposes to give assistance to the Transdniestrian Region of Moldova to improve the capabilities of the local radiation safety authorities, expert assistance from IAEA can be considered.

Figure 1: Contaminated steel products from the source-melting (^{60}Co) event, in store

Figure 2: Storage facility for contaminated dust resulting from the source-melting event in 2002

Figure 3: Side view of the contaminated dust storage facility

Figure 4: Rainwater drain system and sampling vault of the contaminated dust storage facility

Figure 5: Tanks containing contaminated dust from the source-melting event (^{137}Cs) in 2003

Figure 6: Sampling of the contaminated dust from the source-melting event (^{137}Cs) in 2003

Figure 7: Construction of the new storage facility for contaminated dust from the source-melting event (^{137}Cs) in 2003

Figure 8: Entrance of the open-air dust storage site and the storage building (left) for contaminated steel product

Figure 9: Sampling of dust at the open-air storage site

Figure 10: Testing the contamination of a truck which was used for transporting contaminated dust

Figure 11: Sampling point on the road from Chisinau to Rybnitsa, about 15 km from the west bank of the Dniester river

ANNEX

Part A:

Report of analysis for determination of gamma-emitters in samples

Part B:

Report of analysis for determination of beta and alpha emitters in samples

INTERNATIONAL ATOMIC ENERGY AGENCY
IAEA'S Laboratories at Seibersdorf and Vienna,
Chemistry Unit

Report of Analysis No. CU-04-0?? Date: 2004-03-01

Determination of gamma-emitters in samples from Moldova

1. Testing Laboratory
Chemistry Unit
IAEA Laboratories Seibersdorf
A-2444 Seibersdorf
Austria

2. Analyst
Marek Makarewicz
Chemistry Unit

3. Proposal for analysis No. (PfA) and/or work assignment (WA) number(s)

CU0313

4. Counterpart

Mr. G. Massera

IAEA, NAAL

Seibersdorf

5. Analysis requested from the analyst

Identification and quantification (activity concentration) of anthropogenic gamma-emitting nuclides, and estimation of mass density of samples SA-10 and SA-11.

6. List of samples and description

Refer to Table I.

7. Reason for request

Refer to the Request for Analysis CU0313

8. Other information if relevant for the validity and/or application of results

9.Technique and method used

γ-ray spectrometry, see CUP.RA.001

10. Description of analytical method

The test material was not processed and was used as received. All received samples (25) were screened, and 17 samples (SA-1 through SA-18, and Scoria 1 and Scoria 2) were quantitative transferred into standard counting vials (model B70) and submitted for analysis.

Five samples (#618, #619, #620, #629, and #630) could not fully fill a standard volume of B70 vial ((70.0 ± 0.5) cm^3), and an additional calibration for efficiency was performed for a consensus volume (B70, sample height h=0.77 cm). The results of activity concentration for those five samples were not corrected for sample density and atomic composition. The activity error due to skipping that correction is less than 3%.

Other samples were evaluated with a standard efficiency calibration function for B70 filled fully (h=2.2 cm) with 2M HCl certified multinuclide solution. Obtained results of activity concentration for Cs-137 were corrected for a sample self-attenuation. For that correction mass attenuation coefficients were used, determined in a series of measurements for each individual sample.

The results of activity concentration were corrected for contribution of environmental background radiation.

11.Deviations from active instructions and procedures

In generic gamma-ray spectrometry procedure, it is assumed that mass attenuation coefficient is known or can be easily evaluated using available information on atomic composition of a sample and tabulated data for elements. For this work mass attenuation coefficients were measured since the atomic composition of several samples (particularly scraps from melting furnace) could be hardly estimated (identified ???).

$$\left(\frac{\mu}{\rho}\right) = -\frac{1}{\rho x}\ln\frac{R_1 - R_s}{R_0}$$

where (μ/ρ) is the mass attenuation coefficient of a sample material, ρ is the sample mass density, x is the average path length of photons in a sample, R_0 is the count rate in a spectral peak at 662 keV from an external Cs-137 point source, R_s is the count rate from a sample, and R_1 is the count rate from both sample and the external source.

For the experimental setup used (external point source to the detector crystal distance of H=9.37 cm, and the crystal diameter of 5.76 cm) the following formula was derived:

$$x = 1.023\,h$$

where *h* is the thickness of the sample material, and the standard uncertainty of the numerical factor was assumed to be 1%. Uncertainty of count rates: $u(R_0)/R_0$=0.3%, $u(R_1)/R_1$=1%, and $u(R_s)/R_s$=1%.

12. Instrumentation and software used

Detector: "LowLevel", HPGe p-type; relative efficiency of 69% and resolution of 2.00 keV at 1.3 MeV.

Electronics: EGG Ortec model HV 660, Canberra spectroscopy amplifier model 2025 (6 μs), Canberra ADC 8075 (8K), PC board Canberra model S-100.

Software: Canberra Genie-2000 ver. 2.0

Mass attenuation coefficient was measured with GEM30 HPGe detector (26% in relative efficiency, and FWHM=1.8 keV at 1332.5 keV).

13. Results

The results of measurement of 15 samples in two series are shown in Tables II and III and in Figs. 1 and 2, respectively. The results of 20 measurements of the sample #588 are shown in Table IV and Fig. 3.

14. Information on QC measures performed

Periodic performance check of the system with a bulk standard source.

15. Uncertainty estimation of the measurements

Uncertainty in the results of net count rate was calculated by combining the uncertainties of net areas of spectral peaks from test material and environmental background radiation.

16. Extended information

none

17. Discussion of results

Only the results for the gamma-line at 186 keV (Ra-226 and U-235) could be used for testing homogeneity of the material. Other spectral peaks are too weak (large uncertainty) to be appropriate for the detection of heterogeneity of the order of 5% percent, or belong to radon progenies.

An unusually high rate of radon emanation is observed. This effect is most probably related to the small grain size of the particles constituting the IAEA-434 material. At the time when the 1st series of measurements started, only four samples #588-#591 were sealed with plastic tape, and in addition the sample # 588 was prepared and sealed a week earlier. Consequently, the sample #588 shows the highest concentration of radon decay products (Fig. 1). The results for three other sealed samples are greater than those for unsealed samples but significantly lower than that for #588 since they were sealed just before the series of measurements started.

There was an opportunity to repeat the measurement of all the 15 samples. At that time all samples were sealed; the tape was put on 2003-06-25 and kept up to 2003-07-16. The 2nd series of measurements started on 2003-07-10, but only a few samples were still sealed (#588, #589, and #597-

#602). For those samples the results for radon progenies concentration are significantly higher than for re-sealed samples (~10%, Fig. 2).

It was also observed that the samples made of IAEA-434 absorb humidity (see Fig. 3). In the period from 2003-05-21 to 2003-2003-07-16, unsealed samples absorbed ~400 mg to 500 mg water from atmosphere and sealed samples approximately a half of it.

For better characterization of the material IAEA-434, it would be valuable to perform a systematic observation of sample behaviour with respect to humidity absorption and build-up of radon progenies.

18. Other references on methods

19. Reference to sample and data trackability

Samples were registered in a sample logbook "Sample 2"

All spectra collected are stored as compressed data files (*.zip) as follows:

L1715_cnf.zip – 1st series of measurements,

L1721_cnf.zip – 2nd series of measurements,

L1716_#588_001-025_cnf.zip – a series of 20 measurements of the sample #588,

Intermediate and final results of the measurements are stored in Excel spreadsheets:

L1716_Results_186-352-609-1765.xls

L1721_Results_186-352-609-1765.xls

L1751_Results_186-352-698-1765.xls

20. Personnel involved in the analysis

Marek Makarewicz

21.Reporting Analyst

Marek Makarewicz

Signature of analyst(s)

Printed name: Marek Makarewicz Date: 2003-08-13

Approval for release:

Signature of Head, CU

Printed name: Kerry Burns Date:

cc.: Result file (copy)

Counterpart (original)

Note:

Reported results apply only to the samples as received and measured.

Table I. List of samples from Moldova: swipes (8 samples), soil and scrap from melting furnace (15 samples), and scoria gravel (2 samples).

			Measured samples		
No.	Customer's code	CU code	Sample ID	Sample mass (g)	Counting time
1	S-1	CU031300100			
2	S-2	CU031300200			
3	S-3	CU031300300			
4	S-4	CU031300400			
5	S-5	CU031300500		measured as received	
6	S-6	CU031300600			
7	S-T1	CU031300700			
8	S-T2	CU031300800			
9	SA-1	CU031300900	#620	14.19	189
10	SA-2	CU031301000	#619	23.98	164
11	SA-3	CU031301100	#618	22.55	284
12	SA-7	CU031301200	#614	88.62	18
13	SA-8	CU031301300	#615	77.49	6
14	SA-9	CU031301400	#616	84.25	6
15	SA-10	CU031301500	#621	110.90	1010
16	SA-11	CU031301600	#622	129.21	207
17	SA-12	CU031301700	#627	71.07	1072
18	SA-13	CU031301800	#628	63.06	115
19	SA-14	CU031301900	#617	123.70	81

20	SA-15	CU031302000	#613	119.39	911
21	SA-16	CU031302100	#611	105.07	3982
22	SA-17	CU031302200	#626	84.69	1357
23	SA-18	CU031302300	#625	58.89	3910
24	Scoria 1	CU031302400	#629	42.89	5711
25	Scoria 2	CU031302500	#630	60.14	2821

Table II. Activity concentration in samples from Moldova.

Reference date: 2004-01-16.

	Customer's code	CU code	Sample ID	Cs-137 (Bq kg^{-1})	Co-60 (Bq kg^{-1})	K-40 (Bq kg^{-1})
1	S-1	CU031300100		< 0.3[A], screening		
2	S-2	CU031300200		< 0.3, screening		
3	S-3	CU031300300		< 0.3, screening		
4	S-4	CU031300400		< 0.3, screening		
5	S-5	CU031300500		< 0.3, screening		
6	S-6	CU031300600		< 0.3, screening		
7	S-T1	CU031300700		< 0.3, screening		
8	S-T2	CU031300800		< 0.3, screening		
9	SA-1	CU031300900	#620	5,145 ± 58[B]	< 9.3	395 ± 47
10	SA-2	CU031301000	#619	983 ± 27	< 12	1,034 ± 73
11	SA-3	CU031301100	#618	448.3 ± 7.4	< 5.4	535 ± 41
12	SA-7	CU031301200	#614	116,700 ± 1,200	< 8.3	437 ± 62
13	SA-8	CU031301300	#615	100,700 ± 1,100	< 19	< 530
14	SA-9	CU031301400	#616	134,300 ± 1,400	< 20	< 490
15	SA-10	CU031301500	#621	90.5 ± 1.3	< 1.0	250 ± 20
16	SA-11	CU031301600	#622	312.0 ± 4.7	< 2.2	218 ± 21
17	SA-12	CU031301700	#627	191.3 ± 2.4	< 1.2	475 ± 37
18	SA-13	CU031301800	#628	454.0 ± 8.0	< 4.6	509 ± 48

19	SA-14	CU031301900	#617	2,978 ± 34	< 2.5	170 ± 19
20	SA-15	CU031302000	#613	95.5 ± 1.3	< 0.82	195 ± 16
21	SA-16	CU031302100	#611	7.46 ± 0.17	< 0.47	508 ± 39
22	SA-17	CU031302200	#626	128.0 ± 1.6	< 0.91	217 ± 17
23	SA-18	CU031302300	#625	11.68 ± 0.31	< 0.72	217 ± 17
24	Scoria 1	CU031302400	#629	8.12 ± 0.22	< 0.57	17.1 ± 2.9
25	Scoria 2	CU031302500	#630	4.65 ± 0.19	< 0.57	14.9 ± 2.6

[A] the symbol “less than” (“<”) means that the nuclide of interest has not been detected and the detection limit is reported

[B] the result, e.g. 5,145 ± 58, means (5145 ± 58) Bq kg^{-1} or (5.145 ± 0.058) kBq kg^{-1}

Table III. Mass density of samples from Moldova submitted for γ-ray spectrometric measurement and mass attenuation coefficients of those sample materials.

Sample	Sam ID	rho	(mu/rho)	u((mu/rho))
SA-07	#614	1.27	0.0828	0.0068
SA-08	#615	1.11	0.0890	0.0070
SA-09	#616	1.20	0.0936	0.0077
SA-10	#621	1.26	0.0723	0.0043
SA-11	#622	1.23	0.0728	0.0044
SA-12	#627	1.02	0.0788	0.0052
SA-13	#628	0.901	0.0775	0.0058
SA-14	#617	1.77	0.0777	0.0036
SA-15	#613	1.71	0.0701	0.0035
SA-16	#611	1.50	0.0787	0.0039
SA-17	#626	1.21	0.0729	0.0045
SA-18	#625	0.841	0.0777	0.0061
STD	#623	1.033	0.0816	0.0054

Table IV. Results of measurement of mass density of two samples from Moldova, in units of (g cm^{-3}).

Mechanical treatment	SA-10	SA-11
uncompressed (loose)[A]	1.03	1.06
compressed (100 hits)[B]	1.29	1.29
compressed (200 hits)	1.32	1.32

[A] A measuring cylinder was freely filled with sample material

[B] Filled cylinder was tapped for 100 times against a table surface

Table V. Detection limits for Am-241 in selected samples from Moldova.

Reference date: 2004-01-16.

Customer's code	CU code	Sample ID	Am-241 (Bq kg^{-1})
SA-1	CU031300900	#620	110
SA-2	CU031301000	#619	230
SA-3	CU031301100	#618	36
SA-7	CU031301200	#614	650
SA-8	CU031301300	#615	1,200
SA-9	CU031301400	#616	1,300
SA-10	CU031301500	#621	6.1
SA-11	CU031301600	#622	17
SA-12	CU031301700	#627	7.8
SA-13	CU031301800	#628	30
SA-14	CU031301900	#617	4.5
SA-15	CU031302000	#613	5.7
SA-16	CU031302100	#611	3.2
SA-17	CU031302200	#626	6.1
SA-18	CU031302300	#625	4.6
Scoria 1	CU031302400	#629	3.6
Scoria 2	CU031302500	#630	3.7

Part B

Report on beta and alpha emitters in samples

Dear Gustavo,

Here are the results of radiochemical measurements on the dust and scoria from scrap metal melting furnace, and some interpretation, as we discussed:

Sample	CU code	$^{239+240}$Pu Bq/kg	^{238}Pu Bq/kg	^{238}Pu/$^{239+240}$Pu	^{241}Pu Bq/kg	^{241}Am Bq/kg	^{90}Sr Bq/kg
Scoria2	**CU031302500**	**0.11±0.03**	**0.017±0.05**	**1.5±0.5**	**12.0±4.5**	**0.10±0.04**	**<4.6**
SA-9	**CU031301400**	**0.07±0.02**	**0.09±0.03**	**1.3±0.6**	**7.8±4.1**	**0.13±0.03**	**<24**

The reported uncertainties are multiplied by the coverage factor k=2, providing a level of confidence of approximately 95%.

For the Am and Pu alpha-spectrometry measurements after radiochemical separation I needed about 400 000 s counting time.

The measured activity concentration values are not higher than the mesaurable values in normal topsoil environmental samples, only the

^{238}Pu/$^{239+240}$Pu ratio indicates indicates different origin, -most probably the reprocessed fuel- from which the ^{137}Cs /fission product/ source was prepared.)

The **^{238}Pu/$^{239+240}$Pu** ratio is about 0.02-0.05 in case of global fallout and about 0.5 in case of the Chernobil fallout.

For comparison the information values on SOIL-6, a reference material taken from upper Austria (upper 10 cm soil) before the Chernobil accident:

$^{239+240}$Pu Bq/kg: 1.04and ^{90}Sr Bq/kg: 30.34.

Best Regards,

Gyula