STATUS RESULTS OF AN ANNUAL CAMPAIGN OF CONTINUOUS MEASUREMENT OF AIR RADIOACTIVITY IN NOVOZYBKOV (BRIANSK REGION) - RECENT DATA OF A RUSSIAN - FRENCH STUDY

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Abstract

At the request of the Association of Radiological Problems of Russia(ARPR), in charge of environmental measurements and clean up of contaminated territories by Chernobyl accident, an instrument measuring continuously the radioactivity of aerosols in the environment was installed and operated for demonstration during a complete annual cycle in NOVOZYBKOV, Briansk Region (RUSSIA), in order to determine locally residual atmospheric contamination.

This measuring campaign was carried out using the so called RADAIR instrument. This campaign was organised in the framework of a Russian - French cooperation between IPPE (Institute of Physics and Power Engineering, OBNINSK), SEC-SNIIP (Scientific and Engineering Center "SNIIP" , MOSCOW) , IPSN (Institut de Protection et de Sûreté Nucléaire , Fontenay-aux-Roses) and MGP-Instruments (LAMANON).

The first step of the operation consisted in a preliminary verification of the instrument calibration in the site, using aerosols sources deposited on filters . This calibration carried out on specialised facilities of IPSN(1) and SEC-SNIIP(2) showed a satisfactory agreement between different results.

The second step consisted in exploiting the instrument. Beside the demonstration that the instrument worked suitably during its continuous operation in variable climatic conditions, the results obtained showed :

- that the indicated volume activities of α and β emitters were low and near the instrument minimum values (for α : 4.10^{-3} $Bq.m^{-3}$ and for β : 10^{-1} $Bq.m^{-3}$) ;
- that the indicated volume activities of ^{222}Rn lie between 2 and 30 $Bq.m^{-3}$ (the high values are obtained in favourable climatic conditions : no wind, no rain or snow, soil not covered by snow and not frosted, etc.) ;
- that the indicated environmental dose rate values at the point of measurement were of the order of 0.15 $\mu Gy.h^{-1}$ (150 $nGy.h^{-1}$).

This paper summarises all the results obtained.

1 - INTRODUCTION

In order to survey the air volume activity of a region, for the purpose of radiation protection, most industrialised countries have installed air measuring networks. The characteristics and performances of measuring instruments in the network are specified in IEC standards.

The type testing of these instruments, according to these standards, gives the demonstration that the volume activity indications lie within stated requirements. It is also necessary to study the characteristics of the instrument in the real field and to give to the user the possibility to exploit it, in order to have feedback experience.

In february 1993, in response to a request from the Russian Association of Health Physics Problems (ARPR), the organisation in charge of environmental measuring and clean up of regions contaminated by Chernobyl accident in the Briansk area, and within the framework of BNEN protocol (Office for Standardisation of Nuclear Equipment) a recommendation was made to install and to operate for demonstration purposes, an instrument for continuous measuring aerosol radioactivity in the environment. This project was carried out jointly by IPPE (Institute of Physics and Power Engineering, OBNINSK), SEC-SNIIP (Scientific and Engineering Center "SNIIP", MOSCOW), IPSN (Institute of Nuclear Protection and Safety, Fontenay-aux-Roses and Saclay) and MGP Instruments (LAMANON). It has received financial support from the French Ministry of Foreign Affairs.

(1) ICARE : Installation de Calibration à l'aide d'Aérosols Radioactifs Etalons.
(2) SAS : Special Aerosol Source.

This project was designed for the following objectives :

1. to test and to exploit an instrument, the so called RADAIR, in the real field where climatic conditions might vary from severe cold winter to hot summer, during a year cycle ;

2. to measure continuously the aerosol radioactivity after ten years from the Chernobyl accident in NOVOZYBKOV (Briansk region), specially during seasons where aerosol resuspension might occur ;

3. to receive on line RADAIR data transmitted to Saclay by ARGOS system, so to survey the operation and the status of the instrument.

Prior to this operation, an intercomparison of activity deposited on filters produced by SAS facility (SEC - SNIIP) and ICARE facility (IPSN) serving during type testing of this kind of instruments was organised. The purpose of this intercomparison was to prove that calibration of α and β deposited activities in Russian and French laboratories are comparable within know limits.

2 - INTERCOMPARISON OF ACTIVITY MEASUREMENTS OF RADIOACTIVE AEROSOLS COLLECTED ON FILTERS

This intercomparison took place in 1993-1994 for the reason mentioned above. Filters of the same type, millipore membrane, AAWP 0.8 μm thick, were used. The characteristics of deposited activities were the following :

- for SEC - SNIIP Laboratory ^{239}Pu , ^{90}(Sr + Y) and natural U were deposited by generating with SAS facility polydispersed aerosol of the inhalable sizes.
- for the IPSN Laboratory ^{239}Pu and ^{137}Cs were deposited by generating with ICARE facility monodispersed aerosol of 0.4 μm.

The measurements were carried out in SEC-SNIIP and IPSN Laboratories using absolute and instrumental methods without knowing the values. The results were published in the reference [1]. They showed that calibration in Russian and French Laboratories of deposited activities, when the uncertainties are between ± 2 % and ± 5 %, for all radionuclides, except natural U, are comparable within ± 10 %. For natural U, the deviation of ± 20 % is due to uncertainties in the methods of measuring this radionuclide. Moreover, the fact that instrumental method gave comparable results with absolute one for submicron aerosol particulates proved that their penetration in the filtering media can be considered as negligible. This was a confirmation of the choice of these membrane as a reference filter.

3 - OPERATIONAL PRINCIPLE OF RADAIR INSTRUMENT

This instrument was chosen for the following reasons :

1 - it is rugged, easy to install in open air and to exploit ;

2 - it separate finer thoracic aerosol fraction of less than 10 μm for continuous measurements, while segregating the course extra-thoracic fraction and iodine in a collecting cartridge for later gamma spectrometry analysis.

The operational principle was published in reference [2]. Essentially for the continuous measurement function, RADAIR instrument carry out, on four measuring channels, the following readings :

- volumes activities of α and β artificial emitters in $Bq.\ m^{-3}$;
- volume activity of natural radon in $Bq.\ m^{-3}$;
- ambient γ dose equivalent to ^{137}Cs in $\mu Gy.h^{-1}$.

The volume activity readings are derived from pulse counting in cycles of 1000 s of the activity deposited on AW 19 filter by sampling the environmental air. The filter automatically moves after remaining 24 hours in front of the stack of two semiconductor detectors. The first detector located above the filter, delivers a net pulse counting rate proportional to the deposited activity. The discrimination between artificial and natural radionuclides is achieved by the following way :

- radial collimating grid is placed between the filter and this detector to improve α resolution ;
- AW 19 membrane filter is chosen because the aerosols are collected superficially and so the α resolution is better ;
- pulse amplitude selection associated with α and β processing algorithms separate artificial from radon daughters emitters.

The second detector located above the previous one corrects the counting rate of the first detector from the influence of γ radiation and by this way performs ambient γ compensation. The counting from the second detector in cycles of 1000 s is converted to a γ dose rate display.

4 - PROJECT IMPLEMENTATION

Russian and French experts worked on the preparation of the project for three months before it became operational (from august 1994 to october 1994).

On october 30, 31, 1994, a RADAIR instrument was installed on site at the interdepartmental Radiology Laboratory in Novozybkov, located about 180 km from Chernobyl. An operational test was performed november 1, 1994. Calibration verifications were performed november 2, 1994, using aerosols of ^{239}Pu, ^{137}Cs and ^{90}(Sr + Y) deposited on filters, which were manufactured by methods using ICARE (IPSN) and SAS (SEC-SNIIP) installations. The results of these calibration tests were published in reference [3]. Taking into account that RADAIR uses a fixed efficiency of 3.10^{-2} pulses.s^{-1} /Bq to convert pulse rate into activity, it was found that deviations of indicated values from the nominal ones were within ± 15 %.

Since november 2, 1994, the instrument was in continuous operation and under surveillance of two IPPE persons who worked in rotation. Between november 2, 1994 and october 13, 1995, various calibration checks were performed. The results of these checks were the same as those obtained at the time the instrument was put into operation, november 2, 1994.

The RADAIR filters which have aspiration tracks lasting from 46 hours 40 minutes and 15 hours were analysed using α spectrometry (technique using a grid chamber or a silicon semiconductor). ^{226}Ra and products of ^{222}Rn and ^{220}Rn were found to be present in the α spectra.

5 - CONCLUSIONS

After examination of the IPPE exploitation report obtained using the results from the volume activities and dose rates indicated by RADAIR printer, the following conclusions have been drawn :

1 - overall, the volume activities of artificial α and β emitters are low and close to the minimum values (for α : 4.10^{-3} Bq. m^{-3} and for β : 10^{-1} Bq. m^{-3}).

2 - in general, the activity concentrations of radon remained lower than 30 Bq.m^{-3}.

The highest concentrations were obtained under the following conditions :

- light wind (speed of $\leq$ 2 m.s^{-1}), and high atmospheric pressure (P > 740 mm of mercury),
- no precipitation, and no snow or ice groundcover.

The lowest values, lower than 5 Bq.m^{-3}, were obtained under the following conditions :

- high winds (speeds of $\geq$ 5 m.s^{-1}), and low atmospheric pressure (P < 730 mm of mercury),
- groundcover of snow or ice,

3 - The γ dose rates were around 0.15 μGy.h^{-1} (150 nGy.h^{-1}).

This project has demonstrated that overall, the RADAIR instrument operated correctly in very severe climates (temperatures as low as -30°C, snow, high winds,...). The static calibration checks show the stability of the readouts, within statistical fluctuation limits.

Considering the minimum values mentioned above, the measurements show that, during winter the air contamination is not abnormally high. It was expected that during agricultural work and harvest in spring and summer resuspension might occur, but this was not observed. Similar results were obtained in United Kingdom and Japan [4], [5] in spring season from april to june. They were explained by the action of natural filter played by the vegetation, grass, trees... . From august to september 1995, volume activity readings more than the minimum values were not observed, even though the natural filter is expected to drop as indicated by the references mentioned above. Several examples shown as daily graphs (24 h), taken from the counting of the activity deposited on the RADAIR filter for the α, β, and ^{218}Po channels in 1000s cycles, and before algorithm processing, confirm these conclusions.

6 - REFERENCES

[1] CHARUAU J. et al. Actual calibration of instrument measuring radioactivity of aerosols collected on filters, Journal of Aerosol Science, volume 25, supplement 1, 1994.

[2] GRIVAUD L. et al. Real time measurement of radioactive aerosols in the environment after a 10 µm size selection, to be published in the proceedings of the aerosols European conf. in Helsinki, 1995.

[3] SELDIAKOV Y. et al. Continuous measurement of radioactivity in the air of Briansk region (Russia), calibration of the RADAIR monitor, private communication from the SEC-SNIIP, 1994.

[4] Radioactive fallout in air and rain, results to the end of 1983, AERE - R 1475, dec. , 1984.

[5] Radioactivity survey data in Japan, part 1, NIRS - RSD 102, sept., 1992.