Radiation Monitoring Network in Poland – Structure and Activities

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INTRODUCTION

The Service for Measurements of Radioactive Contamination (SMRC) is carrying out the control of radioactive contamination of the environment and foodstuff in Poland. The Service was brought into existence in 1961. The governmental law gave it organisation structure in 1964. The main task of the control system was to discover unusual levels of contamination overhead Poland in due time, alarm the Polish Authorities and begin assessment and analysis on the radiological hazard of people and environment.

Radioactive fallout caused by the nuclear weapon tests was the source of radioactive contamination of the environment and radiological hazard. The intensive nuclear weapon test program was realised in the years 1954-1959 and 1961-1962. The Service registered the radioactive contamination changes of the environment and foodstuff. The decrease of radioactive contamination level was observed in the following years. After 1964 the Service detected the short-lived increases of radioactivity caused by each nuclear weapon test. Such situation existed till the end of April, 1986.

The station of the Service observed an abrupt increase of radioactive contamination level after the Chernobyl accident. The emergency operation at other stations of the Service was initiated. The results of measurements and assessment were taken into account to undertake proper measures by a governmental commission.

At present, the Service observes the radiation contamination changes remaining after nuclear weapon tests and Chernobyl accident.

STRUCTURE AND METHODS

The Service for Measurements of Radioactive Contamination consists of a network of measuring stations and the Centre of Radioactive Contamination Measurement (CRCM)(1). The Service stations act within the meteorological stations, sanitary-epidemiological stations, veterinary hygiene units, chemical agricultural stations and water supply and sewage establishments. Their content-related activity is co-ordinated and supervised by the CRCM based at the Central Laboratory for Radiological Protection (CLRP). Central Laboratory has been the research base for the measurement stations of the Service. Actually, there are 101 measurement stations located on the territory of Poland (Figure1).

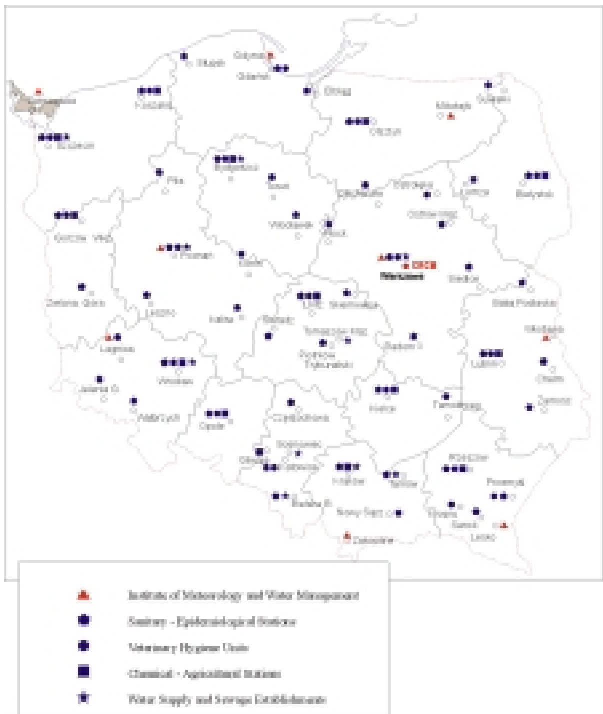

Figure 1. Radiation Monitoring Network

The main task of such stations is the systematic measurement of radioactivity level in samples of environment components and food using uniform methods of measurement. The kind of samples tested by each measurement station depends on the profile of activity of the institution to which that station belongs. For example, air aerosols samples, total fallout and atmospheric precipitation samples are collected by the meteorological stations. Frequency of sampling depends on actual radiological situation, material being collected and on the seasons of the year. Table 1 shows the sampling program of radioactive contamination control taking normal and accident situation into consideration. There are selected points for sampling of the environmental materials and food on the territory of Poland. In case of finding out an increase of radioactivity the number of sampling points may be augmented.

The Service stations of the SMRC measure gamma dose rate using G-M counter probes and may carry out simple measurements of total beta activity of components of environment and food. Total beta activity measurement cannot be the basis for the estimation of doses, but they may be useful for assessment of radioactive contamination level. The total beta activity is measured by scintillation probe with thin plastic scintillator. The measuring set is calibrated using K-40 standard. In case of beta activity measurement of aerosol filters the $^{90}Sr+^{90}Y$ standard is used. The limit of detection is 0.1 Bq per sample. The concentration of individual isotopes in tested samples is determined by radiochemical and spectrometric methods in some of the Service stations. The samples from the remaining Service stations are delivered to the CMRC where such the above mentioned determinations are executed in collected samples. The selective sorption of caesium from the solution of the analysed sample in nitric acid on the surface of AMP bed (ammonium molybdophosphate) is used for radiochemical determination of caesium. The activity of ^{90}Sr is determined by measuring ^{90}Y activity. ^{90}Sr is separated from the solution of the analysed sample, then ^{90}Y is separated after ^{90}Sr-^{90}Y radioactive balance. About 50 Service stations have multichannel analysers with scintillation or germanium detector at their disposal. The standard measurement system SAPOS-90 may be used as a simple 3-channels analyser with NaI(Tl) detector for quick measurements of ^{134}Cs, ^{137}Cs and ^{131}I activities in case of high contamination level.

Table 1. Monitoring program of sampling.

Monitored samples	Normal situation	Accident	
		Direct hazard	After direct hazard
air aerosols	once a day	every two hours	every 2-, 4- or 8-hours according to the situation
total fallout	once a day	once a day	once a day
milk	collected monthly sample of market milk	collected daily sample of market milk	collected weekly sample of market milk
meat, poultry	once a quarter	once a week	once a month
fish	once a quarter	1-2 times during direct hazard period	once a month
eggs	once a year	once a week	once a month
cereals	once a year	1-2 times during direct hazard period	a few times after harvest, after accident
green forage	once a month (May-October)	once a day	2-3 times per month
concentrated feeding stuff	once a quarter	1-2 times during direct hazard period	once a month
root vegetables and potatoes	once a year (August-October)	1-2 times during direct hazard period	once a month
leafy vegetables	once a month during vegetation	once a day	one a week
soft fruit (strawberry, raspberry etc.)	once a month during a pick	1-2 times per week	1-2 times per month
other fruit	once a year (August-October)	1-2 times per week	once a month

The Service stations acting within meteorological stations, Aerosols Sampling Stations (ASS-500) and Permanent Monitoring Stations form a warning system (Figure 2). The meteorological alarm stations are carrying out continuous measurements of gamma dose rate, radioactivity measurement of 24-hours samples of air aerosols collected 2 m above the ground and radioactivity of daily total fallout. The results are coded and sent once a day to the CRCM by the dedicated meteorological communication line. A computer program decodes the results and produces a daily report. In emergency situation the beta activity of air aerosols is measured every two hours. The results are transmitted to the 24 hours duty service at the Central Laboratory for Radiological Protection as quickly as possible. The coded message has top priority before any other meteorological data.

Figure 2. Warning Radiation Monitoring Stations

The Aerosols Sampling Stations, constructed at the CLRP, collect air aerosols on a filter 2 m above the ground. The airflow rate through a filter is 500 m^3 per hour. In normal situation ASS-500 collect air aerosols in a weekly cycle. This enables performing spectrometric measurements of natural and artificial radionuclides deposited on the filter in a wide range of their concentration beginning from 0.5µBq·m^{-3}. In case of finding out an increase of radioactive level the frequency of sampling is augmented.

Permanent Monitoring Stations analyse on-line a spectrum of gamma radioactivity in the vicinity of the station and measure gamma dose rate.

Additionally, the SMRC program is supported by the CLRP research programs such as: - air aerosols analysis collected from 1 to 15 km altitude with the application of airborne sampler placed inside a fuel tank of a jet plane (2), - monitoring of radioactive contamination of surface water of main Polish rivers and lakes, - sampling of soil in about 250 the same points all over the territory of Poland (3).

All measurement results are collected and analysed by the CMRC. The report “Radioactive Contamination of the Environment and Foodstuff in Poland” is elaborated and published on the basis of these results every year (4,5).

RESULTS

Before the Chernobyl accident the activity of fallout from nuclear weapon tests had influence on radioactive contamination level. Radioactive isotopes, fission product of uranium and plutonium have been released. In that time, the mean annual beta activities were: 100 mBq·m^{-3} for air and 40 kBq·m^{-2} for total fallout. In the following years the radioactive contamination of air and fallout was decreasing gradually but we always observed the short-lived increase of radioactivity after each nuclear weapon test in atmosphere (Figure3)(6). The analysis of radioactive contamination level changes carried out after each nuclear weapon test allowed us to believe that our radioactive contamination control was correct.

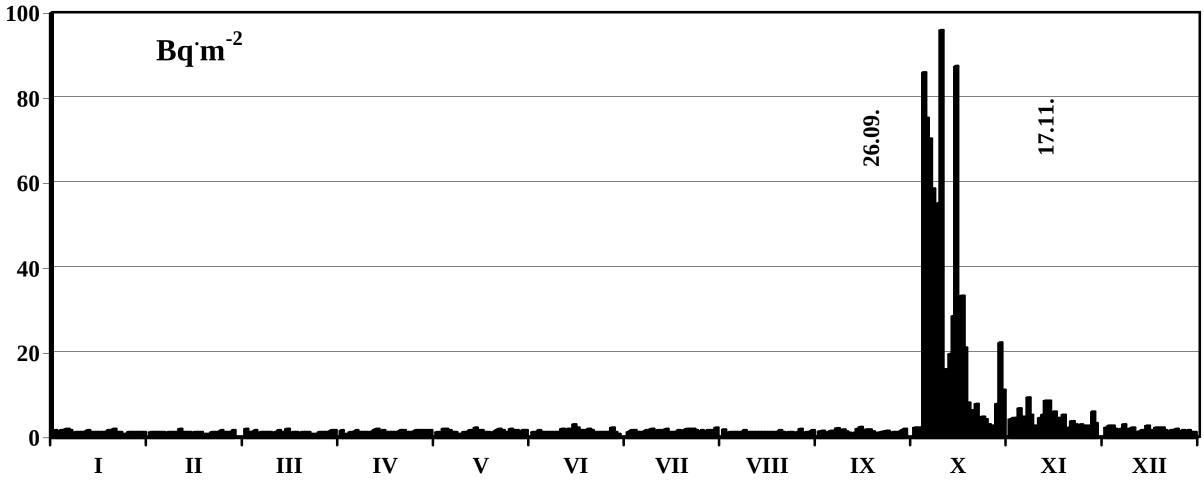

Figure 3. The mean daily total beta activity of fallout in Poland in 1976 (nuclear explosions: 26.09 – in low atmosphere,17.11 – in high atmosphere)

In 1985 the activity of ^{137}Cs was 2µBq·m^{-3} in the air and 6 Bq·m^{-2} in annual fallout. The ^{137}Cs level in top 10 cm soil layer ranged from 0.2 kBq·m^{-2} to 1 kBq·m^{-2}.

The Chernobyl accident caused the growth of the radioactive contamination of the environment in Poland. The fission products were moving with the masses of air according to actual meteorological conditions and then they were depositing gradually on the surface (7). The radioactive contamination appeared in early hours in the morning of April 28, 1986 in Poland. The station of the Service in Mikolajki, in northeaster part of Poland, registered it as the first and alarmed the CRCM . It has been ascertained that reactor accident caused the radioactive contamination. ^{134}Cs was detected in air aerosols filter samples.

In the turn of April and May 1986, the level of radioactive contamination of environment components exceeded many times the results as compared with pre-accident situation. The iodine isotopes were dominating during the first weeks. The amount of caesium isotopes was decisive for the contamination level in the next period. There was no considerable contribution of Sr-90 to the radioactive contamination.

During the accident, the activities of ^{131}I and ^{132}I in atmospheric air were 40 Bq·m^{-3} and 80 Bq·m^{-3}, ^{134}Cs and ^{137}Cs were 2 Bq·m^{-3} and 4 Bq·m^{-3}. In the first two-week total fallout the activity of ^{131}I was on the level from 3 kBq·m^{-2} up to 200 kBq·m^{-2} in different regions of Poland. The activity of ^{137}Cs ranged from 0.6 kBq·m^{-2} to 30 kBq·m^{-2}. In spite of irregularity of radioactive contamination of total fallout, the territory of Poland could be divided into regions of different level of contamination (Figure 4) (8). Local differentiations of contamination were significant.

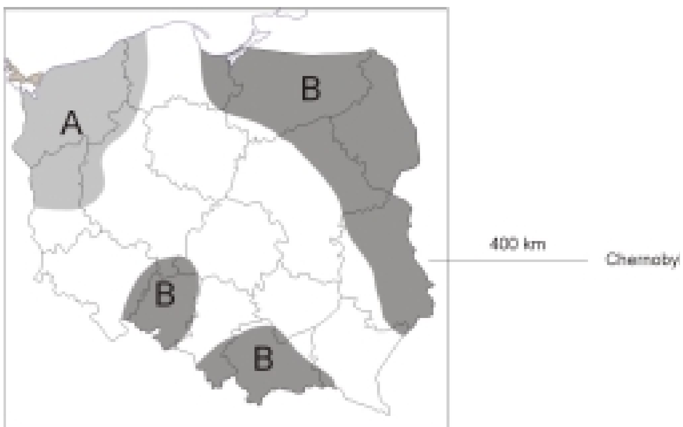

Figure 4. The region of different level of contamination (A-lower level, B- higher level)

In the latter part of the year 1986, the contamination of the air and fallout decreased significantly. The activity of caesium in the air was dozens of $\mu Bq \cdot m^{-3}$ at that time. The activity of caesium in monthly total fallout was a few $Bq \cdot m^{-2}$ in the last months of 1986 (Figure 5). Since 1989 the activity of caesium has been a few $\mu Bq \cdot m^{-3}$ in near-ground air (Table 2) and a few $Bq \cdot m^{-2} \cdot year^{-1}$ in total fallout (3,4,5).

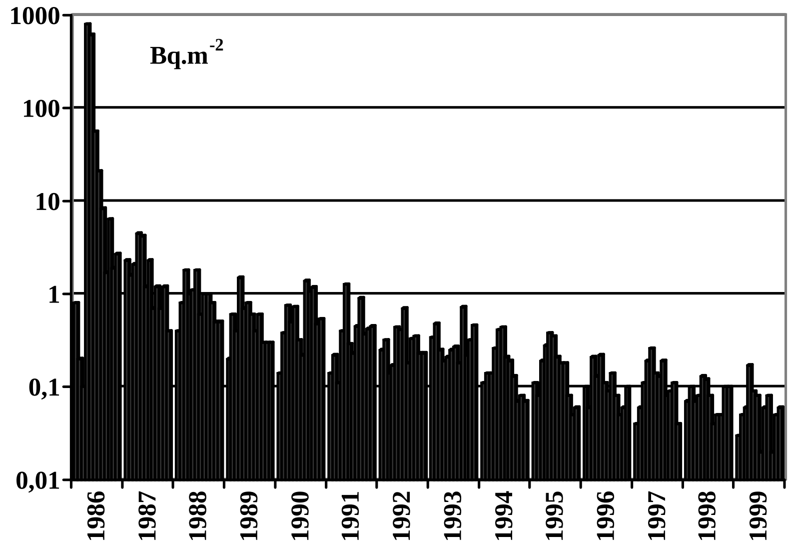

Figure 5. The mean activity of ^{137}Cs in monthly total fallout in Poland

Table 2. Mean annual concentration of ^{134}Cs and ^{137}Cs in near-ground air in Warsaw in 1985-1999, [$\mu Bq \cdot m^{-3}$]

	^{134}Cs	^{137}Cs
1985	---	2
1986	27500	56800
1987	8.5	24.2
1988	2.4	10.3
1989	1.1	6.5
1990	1.1	7.4
1991	0.9	4.7
1992	1.4	5.6
1993	0.4	4.5
1994	0.3	3.4
1995	<0.3	3.3
1996	<0.3	3.0
1997		2.0
1998		2.0
1999		1.6

Higher contamination of soil was observed as a consequence of activity of fallout in April-May, 1986. The ^{131}I activity in soil was 6-200 $kBq \cdot m^{-2}$. From 1988 the concentration of ^{134}Cs and ^{137}C in the top 10 cm soil layer was determined systematically (Table 3)(3,9). In the following years the mean concentrations of ^{137}Cs were changing insignificantly, the concentrations of ^{134}Cs were decreasing in compliance with its half-live period.

Table 3. Concentration of ^{134}Cs and ^{137}Cs in the top 10 cm soil layer in Poland, 1988-1998, (mean values and range), [$kBq \cdot m^{-2}$]

years	1988	1990	1992	1996	1998
^{134}Cs	0.99 0.03-20.1	0.51 0.02-6.8	0.25 0.01-3.4	<0.1 <0.1-1.3	
^{137}Cs	4.7 0.21-81.0	4.7 0.76-54.5	4.2 0.51-49.9	3.7 0.31-37.6	3.49 0.41-34.66

The radioactive contaminations of surface water were much more differentiated than total fallout and soil in May 1986. It depended on a kind and volume of a reservoir. The radioactive contamination was of short-lived. The concentrations of ^{131}I ranged from dozens to several hundred $Bq \cdot l^{-1}$. The concentrations of other isotopes were insignificant. The mean concentrations of ^{137}Cs were below 0.1 $Bq \cdot l^{-1}$ in 1987 and 0.01-0.03 $Bq \cdot l^{-1}$in the next years.

The radioactive contamination of air and soil caused an increase of gamma dose rate, too. Before the Chernobyl accident the mean gamma dose rate was below 0.1 $\mu Sv \cdot h^{-1}$ on the territory of Poland. The maximum values of gamma dose rate from 0.4 $\mu Sv \cdot h^{-1}$ to 4 $\mu Sv \cdot h^{-1}$ were registered between April 28 and May 10, 1986.

CONCLUSIONS

Since the Chernobyl Accident a gradual decrease of contamination level has been observed. Now, the gamma dose rate and the contamination of air, fallout, tap and surface water are on the level of 1985. Only soil contamination is higher. Caesium isotopes are cumulated in 10 cm layer of uncultivated soil. At present, external and internal radiological risk for population caused by inhalation and deposition from artificial isotopes may be left out of account as compared with natural radioactivity (4,5).

The long-lasting activity of the SMRC has made it possible to provide knowledge about radiological situation in Poland as well as monitor changes caused by each nuclear accident. Our control system fulfils all tasks in normal and during accident situations.

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