Detection of Ru-106 in Romania

Authors:

Petre MIN[1] , Andra SMOCOT[1] , Denisa Tănase[1] , Elena SIMION[2] , Ana GHERASIM[2] , Veronica ANDREI[3] , Dan ȘERBĂNESCU[3] , Ion POPESCU[3] , Cristian DULAMA[4] , Alexandru TOMA[4] , Anton COROIANU[5] , Daniel DUPLEAC[6]

1

Summary

The paper aims to present and evaluate the management of events that may lead to the unwarranted presence of artificial radionuclides in the environment in Romania.

In terms of Romanian legislation, which are in line with the terms of specific international standards, the presence of elevated concentrations of the isotope Ru-106 from an external source in the national environment at the end of September 2017 did not represent an emergency situation. At the same time, the presence of elevated concentrations of Ruthenium 106 (Ru-106) in the European area did not at any time constitute a potentially emergency-generating condition. Although the event analysed was not such as to lead to the activation of the National Radiological Emergency Response Plan, it provides an opportunity to review the existing arrangements.

At the end of September 2017, the National Commission for the Control of Nuclear Activities (CNCAN) was informed by the International Atomic Energy Agency (IAEA) about the presence of the isotope ruthenium-106 (Ru-106) in the ambient air in Europe, with the request to carry out measurements on national territory. This request was addressed by the IAEA not only to Romania but to all Member States in the European geographical area.

In response to the IAEA request, CNCAN requested information on the detection of Ru-106, as well as measurements of Ru-106 concentrations in the environment from specialized laboratories in Romania.

Following the analysis performed by the National Network for Monitoring of Environmental Radioactivity RNSRM within the monitoring program for atmospheric aerosol samples taken on 29.09.2017, for the 5-day global beta remeasurement, on 04.10.2017, values higher than those specific to this period were identified, which is why gamma spectrometric analysis of the samples in the laboratories that also perform gamma spectrometry was carried out as a matter of urgency, namely: Arad, Baia Mare, Bucharest, Constanta, Craiova and Iasi.

Gamma spectrometric screening determinations carried out on short measurement times (5000 - 10000 s) revealed the presence of the artificial radionuclide ruthenium-106 (Ru-106).

It is important to note that hourly monitoring of the absorbed gamma dose rate in the air by automated stations, together with immediate global beta analyses of atmospheric aerosols and total atmospheric deposition showed no detectable variations from the natural radiation background.

In September 2017, in the samples taken from 7 locations included in the Environmental Radioactivity Monitoring Program at Cernavoda NPP, the presence of the artificial radionuclide Ru-106 was identified, at a volume specific activity level of the order of mBq/m^3 . This radionuclide had not been identified in aerosol samples until that period and was also not

[1] CNCAN,[2] ANPM,[3] SNN,[4] ICN,[5] SRRp,[6] UPB

detected in gaseous effluents from the plant. No other fission-produced artificial radionuclides, which could be generated by the technological processes of the plant, were identified in the environmental samples analysed.

Also regarding the detection of Ru-106, at trace level, in the atmospheric air of some Western European countries, in the afternoon of 03.10.2017, at ICN Pitesti, an unofficial notification was received from the Institute for Radiation Protection and Nuclear Safety (IRSN) in France, through contacts within the ETSON network. At the same time, CNCAN requested the support of ICN Pitesti to determine the level of radioactive contamination of the atmospheric air and to try to detect Ru-106 in the aerosol samples taken. None of the measurements carried out by ICN Pitesti led to the detection of Ru-106 in the samples taken. However, Ru-106 was subsequently detected in some of the spontaneous vegetation samples taken in November 2017, as part of the environmental radioactivity monitoring programme, with its concentration at levels close to the detection limit of the methods used.

Although there was no potential emergency condition, in the absence of elucidation of the source of the Ru-106 release, i.e. the cause of the release, the public perception that there was a risk factor in this event cannot be dispelled. In these circumstances, the authors considered it appropriate to provide a clear and concise presentation of the way in which public communication was carried out by the Romanian authorities.

The monitoring results did not reveal the presence of any other man-made radionuclides, which is why the possibility of a nuclear reactor accident is excluded.

1. Introduction

The paper aims to present and evaluate the management of events that may lead to the unwarranted presence of artificial radionuclides in the environment in Romania.

Nuclear accidents have both immediate and long-term consequences in terms of effects on human health and the environment and can pose a potential threat to society and the environment. The transparent way in which the Japanese authorities acted in relation to the Fukushima nuclear accident (2011) proved to save lives by rapidly evacuating potentially affected residents and implementing food safety measures. In contrast, the lack of transparency in the USSR's handling of the Chernobyl accident (1986) led to major health and environmental consequences.

During 2017, all the activities of nuclear and radiological installations on the Romanian territory were carried out in accordance with the technical limits and conditions specified in the authorisations and regulations of the National Commission for the Control of Nuclear Activities (CNCAN), without any technical or other incidents that could endanger the nuclear safety of the installations, the safety of the population, the operating personnel or the environment, and without any event likely to produce Ru-106 emissions.

1.1. Presentation of the context of the event

At the end of September 2017, CNCAN was informed by the International Atomic Energy Agency (IAEA) about the presence of the isotope ruthenium-106 (Ru-106) in the ambient air in Europe, with the request to carry out measurements on national territory. This request was addressed by the IAEA not only to Romania but to all Member States in the European geographical area.

In response to the IAEA request, CNCAN requested information on the detection of Ru-

106, as well as measurements of Ru-106 concentrations in the environment from specialized laboratories in Romania. Thus, the laboratories of the National Environmental Radioactivity Monitoring Network (RNSRM) of the Ministry of Environment (National Radioactivity Reference Laboratory of the National Agency for Environmental Protection (ANPM), the Environmental Radioactivity Monitoring Station (SSRM) Constanta of the Agency for Environmental Protection (APM) Constanta) followed up the request, SSRM Iași of the APM Iași, SSRM Craiova of the APM Dolj, SSRM Arad of the APM Arad and SSRM Baia Mare of the APM Maramureş), the Environmental Radioactivity Monitoring Laboratory of the Cernavodă Nuclear Power Plant (CNE), and the Radiation Protection, Environmental Protection and Civil Protection Laboratory of the Institut de Cercetări Nucleare (ICN) Pitești.

The Ru-106 concentrations measured during the period 29.09-03.10.2017 on the territory of Romania were insignificant compared to the level of natural radioactivity in the environment and did not present any danger to the population and the environment. Also, no other artificial radionuclides above the detection limit of the measurement method used were detected in the samples taken, which is a clear indication that the presence of Ru-106 in the atmosphere was not due to an accident at a nuclear reactor.

RNSRM is responsible for monitoring the radioactivity of the environment in Romania and is the national data provider in both normal and emergency situations. Under the technical, scientific and methodological coordination of the National Radioactivity Reference Laboratory - ANPM, RNSRM permanently reports information both to the population (through the ANPM website, www.anpm.ro) and to national (MAI-IGSU, CNCAN, MApN) and international (European Commission on the EURDEP platform) decision makers. RNSRM distribution (laboratories and automatic stations) covers all landforms from the sea, SSRM Constanța and SSRM Sf. Gheorghe - jud. Tulcea, to the mountains, SSRM Toaca and SSRM Babele) and all environmental factors: air, water, soil and vegetation (spontaneous vegetation).

The main objective of the Environmental Radioactivity Monitoring Laboratory of the Cernavoda NPP is to carry out the environmental radioactivity monitoring programme in the area of influence of the Cernavoda NPP, in order to assess the impact of the operation of the two CANDU 6 nuclear reactors on the environment, in correlation with the continuous monitoring of radioactive emissions.

The environmental radioactivity monitoring programme carried out by ICN Pitesti includes all the activities necessary to determine the levels of radioactivity in the environment, as well as their impact on the environment and on the health of the population, both during normal operation of the nuclear installations on site and in emergency situations.

Although the event under review was not such as to lead to the activation of the National Radiological Emergency Response Plan, it provides an opportunity to review existing arrangements.

1.2 Identification, classification, notification and warning of a radiological or nuclear emergency e

Identification and classification of a radiological or nuclear emergency is provided by:

- the operator of the nuclear or radiological facility/source if the event occurred on the site of the facility or when the operator was using or transporting the source;

- by ANPM through RNSRM, in case of detection of high levels of radioactivity on Romanian territory;
- by CNCAN in the case of events occurring on the territory of other countries, which are notified to CNCAN by the international contact points;
- by the IGSU, if events have occurred in ECURIE Member States and are notified to the IGSU by the international contact points.

In order to identify, classify correctly and promptly emergency situations, the following criteria must be met:

- establishing points of contact operating 24 hours a day, 7 days a week (24/7);
- ensuring that managers of facilities or activities (scrap metal yards or scrap metal processing facilities) and national border control authorities are aware of the radiological hazards that may arise;
- Ensuring that first responders are aware of and recognize the indicators, know how to notify and what immediate actions can be taken if a potential or probable emergency situation may occur;
- ensuring a system to promptly initiate emergency response;
- ensuring that response organisations have sufficient staff to identify and classify an emergency.

After identification and classification of the emergency situation, the operator/RNSRM/CNCAN/IGSU are obliged to notify the Public Authorities of the emergency situation.

The notifications that operate at the National Notification Points for radiological or nuclear emergencies are:

- National notifications can be received/transmitted on the basis of national legislation in force and cooperation protocols with partner institutions within the National Emergency Management System.
- International notifications may be received/transmitted under the International Conventions on Early Notification and Assistance in the Case of a Nuclear Accident or Radiological Emergency and/or under bilateral early notification/assistance treaties and/or in various other situations.

The official channels through which notifications are sent or received are faxes and telephones. E-mails and other means of communication are used to exchange information.

For international notifications, National Contact Points (NCPs) are established and operate 24/7:

- PNC within CNCAN, which liaises with the Incident and Emergency Centre organised by the International Atomic Energy Agency.
- PNC within the IGSU, which liaises with the European Commission through the Information Exchange System (ECURIE).

- ANPM's NCP through RNSRM, which links to the EUropean Radiological Data Exchange Platform (EURDEP) organised by the European Commission, Joint Research Centre.

2. Detection and notification

Sampling, measurement and analysis

2.1.1. RNSRM

The air quality in terms of environmental radioactivity on the Romanian territory is continuously monitored within the RNSRM, through 37 laboratories (SSRM) and 86 automatic gamma dose rate monitoring stations, within the Standard Monitoring Programme. Within the Standard Monitoring Programme, hourly determinations of the absorbed gamma dose rate in air and samples of atmospheric aerosols and total atmospheric deposition (wet and dry) are carried out, which are subjected to global beta analysis for verification purposes, as well as gamma spectrometric analysis for the quantitative detection of radionuclides present in the sample.

The methodology of location, sampling and analysis within the RNSRM aims to ensure uniformity of the information provided at a given point in time.

Atmospheric aerosol and atmospheric deposition sampling points are permanent, ensuring traceability of data over time.

The field deployment of sampling devices was based on a unique methodology, which provides the following minimum and mandatory conditions:

- location of sampling devices in open spaces, outside urban agglomerations, away from sources of pollution (road traffic, chimneys, furnaces, etc.).
- the minimum distance between the device and other objects/obstacles (buildings, fences, trees, etc.) on the ground must be twice the height of the obstacle.
- absence of lush vegetation in the area.

Sampling of atmospheric aerosols was carried out on glass-fibre filters with a retention coefficient of 99%, placed 2 m above the ground and connected to suction pumps with a flow rate of 5 m^3 /h. The sampling period was 5 hours, in the time intervals 02:07 (A1), 08:13 (A2), 14:19 (A3), 20:01 (A4). 9 laboratories with 24-hour working hours performed all four samples, and the remaining 28 laboratories with 11-hour working hours performed only the first two samples.

For global beta analyses, low background global beta counting systems were used, and for gamma spectrometric analyses, a network of 6 high purity and high resolution gamma spectrometers with germanium detectors (HPGe) from RNSRM (SSRM Arad, SSRM Constanța, SSRM Iași, SSRM Baia Mare, SSRM Craiova and the National Radioactivity Reference Laboratory - ANPM), Canberra brand, model BE 3820, was used. Genie 2000 *software* was used for the analysis. The energy calibration was performed using the *peaks* in the spectrum, and the ISOCS *software* produced by Canberra was used for the effectiveness calibration. Verification of the effectiveness calibration was done using reference materials purchased from the IAEA. Geometry, density, matrix and summation corrections were performed.

Cernavoda NPP

The main objective of the environmental radioactivity monitoring programme carried out at the Cernavoda NPP is to assess the impact of the operation of the two CANDU 6 nuclear reactors on the environment, in conjunction with continuous monitoring of radioactive emissions.

Air radioactivity in the area of influence of the Cernavodă NPP is monitored by continuous sampling and monthly measurement using 12 fixed stations (Table 2.1), located as shown in Figures 2.1, 2.2 and 2.3. The backup ADI-06 location can be used for special monitoring programmes.

Table 2.1 - Indicator Locations and Reference Locations: AER

Code	City	Location	Location type
ADI-02	Gherghina	Compet	Location Indicator
ADI-03	Medgidia	Weather Station	Location Indicator
ADI -04	Mircea Voda	Cfr race	Location Indicator
ADI -05	Saligny	Unit. Gendarmes	Location Indicator
ADI -06	Cernavoda	Canal lock (reserve)	Location Indicator
ADI-07	Fetești	Weather Station	Location Indicator
ADI -08	Cernavoda	Environmental Control Laboratory	Location Indicator
ADI -09	Seimeni	Dispensing Veterinary	Location Indicator
ADI -10	Rasova	Police Station	Location Indicator
ADI -11	Cernavoda	400 KV station	Location Indicator
ADI -12	Cernavoda	Radioactive Waste Repository	Location Indicator
ADI-13	Cernavoda	TIP	Location Indicator
ADB-01	Topalu	Police Station	Reference Location

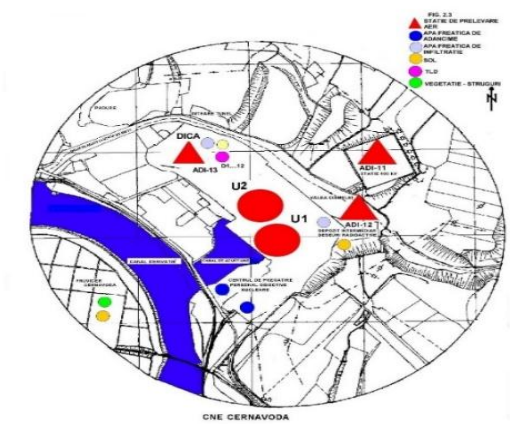


Figure 2.1 - Monitoring stations located on the Cernavoda NPP site
and in the exclusion zone

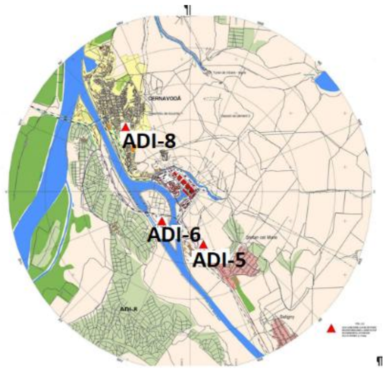


Figure 2.2 - Monitoring stations less than 5 km away

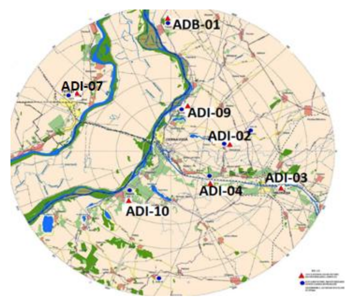


Figure 2.3 - Monitoring stations at distances greater than 5 km

Sampling of solid particulate matter from the air is done with F&J fixed low-flow stations, model LV118ECNV CAS (Figure 2.4).

Figure 2.4 - F&J fixed low flow (10 l/min) sampling station,
model LV118ECNV CAS

The stations provide automatic control of the sampling flow rate between 5 and 25 l/min (i.e. 0.3 and 1.5 m^3 /h) and display the total volume sampled with standard temperature and pressure correction, i.e. 25^o C and 1 atm. The aerosol sampling rate is 10 l/min (0,6 m^3 /h). The operation of the stations is monitored remotely via the internet. The operating parameters of the fixed air monitoring stations are set taking into account the routine emissions of the two nuclear reactors on the Cernavoda NPP site. Filters on which aerosol samples are taken are measured by gamma spectrometry to identify radionuclides and to determine overall beta activity.

2.1.3. ICN Pitesti

The size and configuration of the monitoring programme carried out by ICN Pitesti was made in relation to the nature and size of the radiation sources and taking into account the existing exposure pathways, this being a basic element of the institute's radiation protection programme.

The specific objectives of environmental radioactivity monitoring are:

- detection of any unanticipated changes in activity concentrations and assessment of long-term trends in environmental radioactivity levels as a result of the release of radionuclides into the environment;
- providing the information necessary to assess actual or potential doses to members of the critical group from licensed nuclear activities;
- providing the public with information on the radioactivity of the environment in the area of influence of ICN Pitesti.
- testing the results of the radioactive release monitoring programme and associated models to verify the predictions provided by the models used.

The monitoring programme includes a series of fixed, predefined locations where measurements are taken or samples are taken to determine the radioactivity content. The monitoring locations are classified according to legal requirements into: indicator locations, control locations, background locations and supplementary locations. The types of environmental samples taken under the programme include: surface water, sediment, deep borehole water, drinking water, soil, spontaneous vegetation, aerosols, atmospheric deposition. Types of measurements include determinations of overall alpha/beta activity or concentration, determinations of gamma-emitting radionuclide content, or determinations of natural uranium content, from samples taken. The artificial radionuclides for which specific methods for detection and determination of the level of contamination in environmental samples are foreseen are those included in the list of radionuclides for which CNCAN has approved the derived release limits specific to the nuclear facilities of ICN Pitesti. The sampling and measurement frequency is specified in the programme, starting from continuous sampling (aerosol composite samples and atmospheric deposition) with weekly or monthly measurement of samples, up to half-yearly sampling (surface water, soil, spontaneous vegetation). The results of the environmental radioactivity monitoring programme are correlated with those of the effluent control programme, and the decision to adjust the monitoring frequencies of the environmental factors or to add additional locations is taken on the basis of the indications of the continuous monitoring systems for effluent control. The environmental radioactivity monitoring programme for normal operation also serves as the basis for monitoring during nuclear and radiological emergencies.

Reporting of the results of environmental radioactivity monitoring is done annually by submitting a detailed report to CNCAN.

ICN Pitesti must also immediately notify CNCAN of any significant increase in the level of radiation fields or artificial radioactivity concentrations in the environment that cannot be correlated with the approved emission levels and the environmental transfer model used. In such a situation, a report shall be made within one month of the occurrence at the latest, which shall include, in addition to the radioactive levels detected, a description of the investigations undertaken, the results of the investigations, the actions taken and future actions.

During 2015, a cooperation protocol was signed between RATEN ICN and CNCAN with the aim of increasing the efficiency of emergency management and prevention activities, identification, monitoring, analysis and management of nuclear accident or radiological emergency situations and operational information and technical assistance in accordance with legal provisions and obligations assumed by Romania through international treaties. One of the objectives of this protocol is to provide the necessary technical support to CNCAN in order to perform the function of monitoring the radioactivity of the environment around nuclear facilities, to improve the assessment and analysis of the evolution of emergency situations in case of nuclear events and accidents and to train CNCAN staff involved in the response to a nuclear accident or radiological emergency.

Regarding the detection of Ru-106, at trace level, in the atmospheric air of some Western European countries, in the afternoon of 03.10.2017, at ICN Pitesti, an unofficial notification was received from IRSN, through contacts within the ETSON network. At the same time, CNCAN requested the support of ICN Pitesti to determine the level of radioactive contamination of atmospheric air and to try to detect Ru-106 in the aerosol samples taken.

As a result, additional monitoring of air radioactivity has been started at ICN Pitesti by sampling aerosols and atmospheric deposition. Thus, the aerosol filter corresponding to a monitoring interval prior to the date on which the presence of Ru-106 was reported by other laboratories in Europe was measured by gamma spectrometry and it was decided to start without delay (from 03.10.2017) a continuous sampling with a portable aerosol pump over a longer period of time, in order to reach as low as possible the detection limit for Ru-106. At the same time, the material resulting from the collection of atmospheric deposition from 20.09 - 04.10.2017 was collected and processed for the determination of the content of gamma-emitting radionuclides.

2.1.4. Limitations and constraints

2.1.4.1 RNSRM

At RNSRM there are 37 SSRMs providing continuous sampling from the Standard Monitoring Programmes (SMPs), but also from the Special Programmes (SPs), for which only 6 high-resolution gamma spectrometers are available. Although under normal circumstances, the number of spectrometers is comprehensive, with aerosol and atmospheric deposition samples, as well as surface water samples taken daily, being aggregated monthly for gamma spectrometric analysis.

The artificial radionuclide Ru-103 could not be detected due to the lack of operation of very large volume pumps.

In view of the relatively short half-life of Ru-106 (371.5 ± 2.1 days [http://www.nucleide.org/DDEP_WG/Nuclides/Ru-106_tables.pdf]), the targeted activities, and the number of samples to be analysed in the shortest possible time, the sample measurement strategy was modified as follows:

- A minimum individual measurement time of 5000 s was allocated, which is long enough to detect activities of the order of 10^{-3} Bq,
- The priority samples were atmospheric aerosols and atmospheric deposition from the locations where the spectrometers were located, so that the evolution of the pollutant cloud over Romania could be observed continuously (at 2 m above the ground, on different landforms).
- Particular attention was paid to samples from the mountain laboratories (SSRM Toaca and SSRM Balele), which monitor transboundary contamination over long distances. The limitations imposed by this measure are the difficulty of access to and from these laboratories (weather conditions may cut off access to these laboratories: SSRM Toaca, involves the need for someone to carry samples on foot daily to the base of the slope, and at SSRM Babele, access depends on the operation of the cable car).

2.1.4.2. Cernavoda NPP

The objectives of the environmental radioactivity monitoring program at the Cernavoda NPP site were established in accordance with CNCAN regulations for:

a) Verification of the results of the routine radioactive emission monitoring programme from the two operating reactors and of the environmental radionuclide transfer models used to establish derived release limits;
b) providing the information needed to assess actual or potential doses to members of the critical group resulting from the normal operation of nuclear reactors;
c) detection of any unexpected changes in activity concentrations and assessment of long-term trends in environmental radioactivity levels as a result of the release of radionuclides into the environment;
d) providing information to the public.

In the particular case of air radioactivity measurement the sampling frequency is monthly, so the measurement result will be a monthly average concentration. If increased emissions are recorded as a result of abnormal operation of nuclear systems or accidents, sampling frequencies may be modified by setting up special monitoring programmes. In the case of changes in the radioactivity of the air in the Cernavoda area from sources other than the NPP systems, the monitoring programme only allows qualitative, delayed detection of the presence of radionuclides in the air. It is not possible to estimate the concentration in the air in the absence of other information, e.g. the time interval during which the pollutant cloud crossed the Cernavoda NPP site.

2.1.4.3. ICN Pitesti

The environmental radioactivity monitoring programme at ICN Pitesti was designed in close connection with the effluent monitoring programme, and was not aimed at detecting trace-level environmental contamination from sources external to ICN Pitesti. Thus, in the case of air contamination monitoring, the sampling methodology is so designed as to allow the detection of long-term variation trends in radioactivity levels, and can be adjusted, in abnormal conditions, following the indications of the gaseous effluent radioactivity control systems of the own installations. In the event of airborne contamination from external ICN sources at a level at which on-line gamma dose rate monitoring systems cannot detect a significant increase, that contamination may be detected with a delay of at least one week, representing the duration of a standard sampling interval.

Results

2.2.1. RNSRM

Following the analysis performed by RNSRM in the PSM for atmospheric aerosol samples taken on 29.09.2017, for the 5-day global beta remeasurement, on 04.10.2017, values higher than those specific to this period were identified, which is why gamma spectrometric analysis of the samples in the laboratories that also perform gamma spectrometry was performed as a matter of urgency, namely: Arad, Baia Mare, Bucharest, Constanta, Craiova and Iasi.

Gamma spectrometric screening determinations carried out on short measurement times (5000 - 10000 s) revealed the presence of the artificial radionuclide ruthenium-106 (Ru-106) in samples taken from the eastern part of the country on 29.09.2017. Considering that during 03.10.2017 the presence of Ru-106 radionuclide was also confirmed in other European countries, on 04.10.2017 an emergency investigation of all samples taken during 28.09 - 04.10.2017 was started. Samples taken on 28.09.2017 did not reveal the presence of Ru-106 in any sampling location. The values obtained are presented in Table 2.2 and Figure 2.5.

In order to investigate the dispersion of the pollutant cloud over Romania, during the time interval 29.09 - 03.10.2017, the following premises were taken into account: the evolution of meteorological parameters at national level, as well as the technical and methodological availabilities existing within RNSRM. The path followed by the pollutant cloud over the territory of our country in the period 29.09 - 03.10.2017, shown in Figure 2.5, was from East to West.

Hourly monitoring of the absorbed gamma dose rate in the air by automated stations, together with immediate global beta analyses of atmospheric aerosols and total atmospheric deposition showed no detectable variations from the natural radiation background.

The dispersion of Ru-106 in the environment was high enough that it could not be detected by immediate global beta analyses, being masked by Rn-222, whose atmospheric concentration increases in the autumn period. The presence of artificial radioactivity in the environment was revealed by 5-day global beta analyses (samples taken on 29.09.2017, being measured at 5 days on 04.10.2017), which triggered a detailed investigation by gamma spectrometric analysis. In this context, the presence of Ru-106 was highlighted in daily aggregated samples (between 2 and 4 samples depending on the SSRM work schedule). Gamma spectrometric analyses performed on both individual atmospheric deposition samples and on monthly cumulated samples did not reveal the presence of Ru-106 and Ru-103 radionuclides.

Table 2.2 shows the specific Ru-106 activities obtained from gamma spectrometric analyses of daily cumulative atmospheric aerosol samples.

Table 2.2 - Table of Ru-106 concentrations in atmospheric aerosol samples (sceening analysis)

No. crt	**SSRM**	**Radionuclid**	**Sampling period (summer time)**	**29.09.17 [mBq/m^3]**	**30.09.17 [mBq/m^3]**	**01.10.17 [mBq/m^3]**	**02.10.17 [mBq/m^3]**	**03.10.17 [mBq/m^3]**	**04.10.17 [mBq/m^3]**	**05.10.17 [mBq/m^3]**
1	Alba Iulia	Ru-106	3 AM - 2PM (29.09.2017)	< LD	32.81	75.42	39.42	15.02	< LD	< LD
2	Arad	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	64.42	30.41	9.31	< LD	< LD
3	Babel	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	< LD	< LD	< LD	< LD	< LD	< LD	< LD
4	Bacau	Ru-106	3 AM - 2PM (29.09.2017)	< LD	39.3	24.31	< LD	< LD	< LD	< LD
5	Baia Mare	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	47.467	38.212	24.601	< LD	< LD
6	Bechet	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	66.6	127.57	18.1	< LD	< LD	< LD	< LD
7	Botosani	Ru-106	3 AM - 2PM (29.09.2017)	< LD	51.81	< LD	< LD	< LD	< LD	< LD
8	Brasov	Ru-106	3 AM - 2PM (29.09.2017)	< LD	113.033	54.742	17.442	< LD	< LD	< LD
9	Bucharest	Ru-106	3 AM - 2PM (29.09.2017)	< LD	145	18.096	< LD	< LD	< LD	< LD
10	Buzau	Ru-106	3 AM - 2PM (29.09.2017)	< LD	120.445	< LD	< LD	< LD	< LD	< LD
11	Calarasi	Ru-106	3 AM - 2PM (29.09.2017)	38.007	86.808	< LD	< LD	< LD	< LD	< LD

No. crt	SSRM	Radionuclid	Sampling period (summer time)	29.09.17 [mBq/m^3]	30.09.17 [mBq/m^3]	01.10.17 [mBq/m^3]	02.10.17 [mBq/m^3]	03.10.17 [mBq/m^3]	04.10.17 [mBq/m^3]	05.10.17 [mBq/m^3]
12	Cernavoda	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	81.276	47.233	< LD	< LD	< LD	< LD	< LD
13	Cluj Napoca	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	< LD	< LD	29.08	< LD	< LD	< LD	< LD
14	Constanta	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	88.101	44.308	< LD	< LD	< LD	< LD	< LD
15	Craiova	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	59.81	106.27	33.12	< LD	< LD	< LD	< LD
16	Deva	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	35.8	22.7	< LD	< LD	< LD
17	Focsani	Ru-106	3 AM - 2PM (29.09.2017)	15.17	82.808	24.219	< LD	< LD	< LD	< LD
18	Galati	Ru-106	3 AM - 2PM (29.09.2017)	35.935	37.379	< LD	< LD	< LD	< LD	< LD
19	Iasi	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	80.75	65.797	< LD	< LD	< LD	< LD	< LD
20	Mc Ciuc	Ru-106	3 AM - 2PM (29.09.2017)	< LD	61.76	46.97	< LD	< LD	< LD	< LD
21	Oradea	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	75.06	45.77	< LD	< LD	< LD

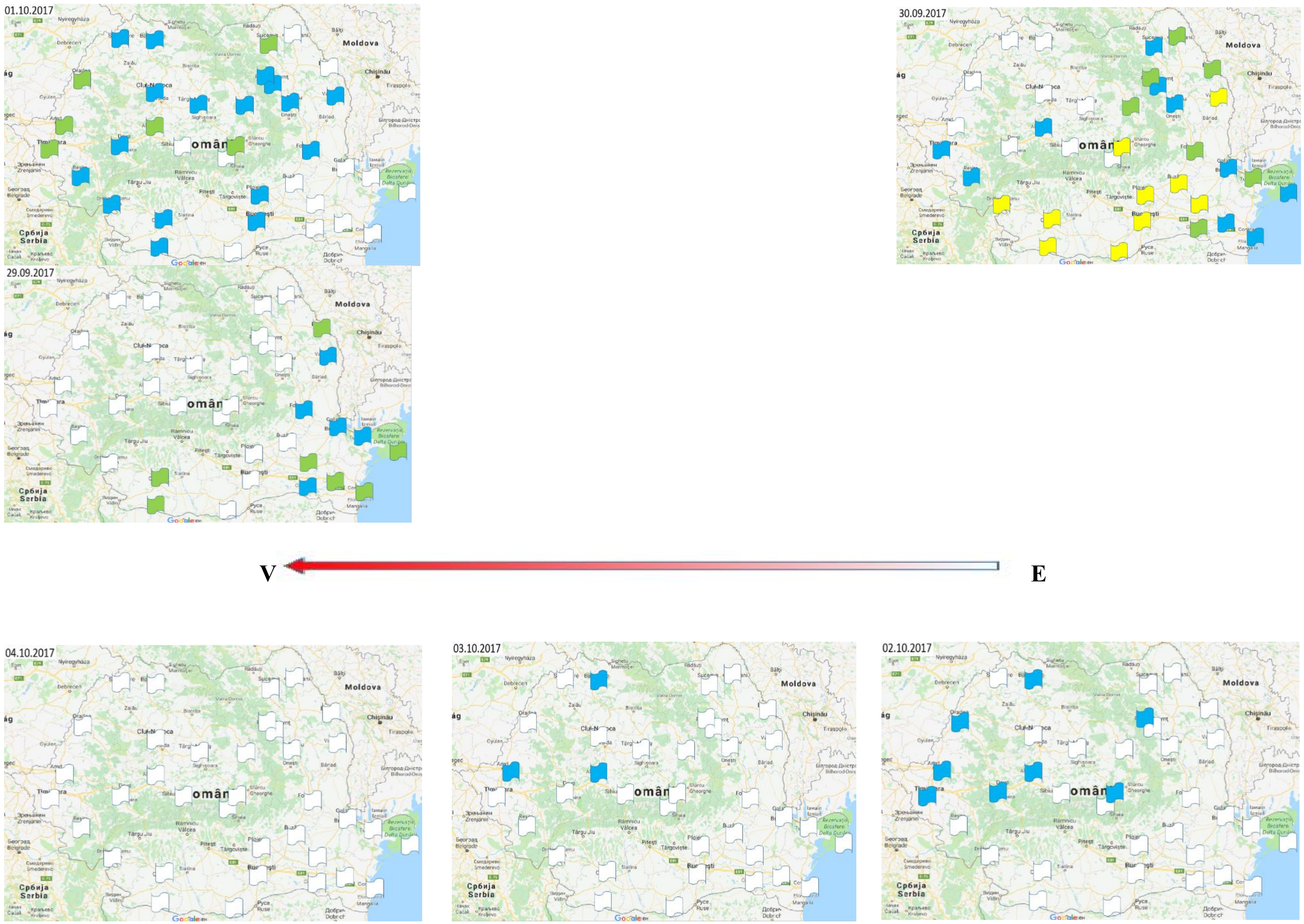
No. crt	**SSRM**	**Radionuclid**	**Sampling period (summer time)**	**29.09.17 [mBq/m³]**	**30.09.17 [mBq/m³]**	**01.10.17 [mBq/m³]**	**02.10.17 [mBq/m³]**	**03.10.17 [mBq/m³]**	**04.10.17 [mBq/m³]**	**05.10.17 [mBq/m³]**
22	Piatra Neamt	Ru-106	3 AM - 2PM (29.09.2017)	< LD	31.729	38.831	< LD	< LD	< LD	< LD
23	Ploiesti	Ru-106	3 AM - 2PM (29.09.2017)	< LD	138.18	46.07	< LD	< LD	< LD	< LD
24	Resita	Ru-106	3 AM - 2PM (29.09.2017)	< LD	50.36	44.42	< LD	< LD	< LD	< LD
25	Satu Mare	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	35.345	< LD	< LD	< LD	< LD
26	Sf.Gheorghe - Tulcea	Ru-106	3 AM - 2PM (29.09.2017)	69.55	34.45	< LD	< LD	< LD	< LD	< LD
27	Sibiu	Ru-106	3 AM - 2PM (29.09.2017)	< LD	55.86	51.88	25.98	< LD	< LD	< LD
28	Slobozia	Ru-106	3 AM - 2PM (29.09.2017)	55.627	118.775	< LD	< LD	< LD	< LD	< LD
29	Suceava	Ru-106	3 AM - 2PM (29.09.2017)	< LD	22.805	52.28	< LD	< LD	< LD	< LD
30	Tg Mures	Ru-106	3 AM - 2PM (29.09.2017)	< LD	< LD	42.326	< LD	< LD	< LD	< LD
31	Timisoara	Ru-106	3 AM - 2PM (29.09.2017)	< LD	30.03	82.88	31.99	< LD	< LD	< LD
32	Toaca	Ru-106	3 AM (29.09.2017 - 2 AM (30.09.2017)	< LD	58.284	12.857	12.898	< LD	< LD	< LD

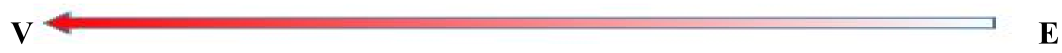
No. crt	SSRM	Radionuclid	Sampling period (summer time)	29.09.17 [mBq/m^3]	30.09.17 [mBq/m^3]	01.10.17 [mBq/m^3]	02.10.17 [mBq/m^3]	03.10.17 [mBq/m^3]	04.10.17 [mBq/m^3]	05.10.17 [mBq/m^3]
33	Drobeta Turnu Severin	Ru-106	3 AM - 2PM (29.09.2017)	< LD	123.5	47.56	< LD	< LD	< LD	< LD
34	Tulcea	Ru-106	3 AM - 2PM (29.09.2017)	50.005	82.571	< LD	< LD	< LD	< LD	< LD
35	Vaslui	Ru-106	3 AM - 2PM (29.09.2017)	44.22	132.772	21.791	< LD	< LD	< LD	< LD
36	Zimnicea	Ru-106	3 AM - 2PM (29.09.2017)	< LD	176.09	< LD	< LD	< LD	< LD	< LD

Note:
1. LOD - limit of detection

2. Individual gamma spectrometric analyses of atmospheric aerosol samples from SSRM Pitesti were not performed, as they were not identified by day.

After the immediate analyses, gamma spectrometric determinations were performed on the monthly cumulative samples, the values obtained being in direct correlation with the individual ones. In this context, the samples from SSRM Pitesti were within the range of values obtained for neighbouring counties.


01.10.2017
30.09.2017
29.09.2017
V
E
04.10.2017
03.10.2017
02.10.2017



Caption:

- Limita de detecție
- 9,31 – 50 mBq/mc
- 51 – 99 mBq/mc
- 100 – 176,09 mBq/mc

Figure 2.5 - Evolution of Ru-106, over Romania, from 29.09.2017 to 04.10.2017 vs. direction of air currents

At the same time, from the analysis of the data presented in Table 2.2 it can be noted that in most of the monitoring locations the time period in which Ru-106 values above the detection limit were recorded was approx. 2 days, with maximum values recorded in the interval 30.09. - 01.10.2017, as can be seen from the percentage distribution of data plotted in Figure 2.6.

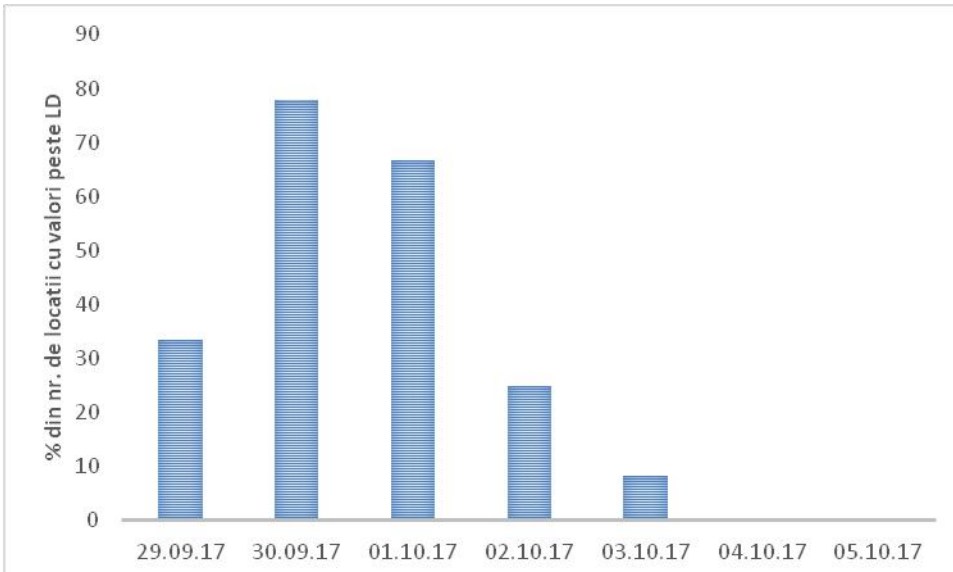


Figure 2.6 - Percentage distribution of Ru-106 values, 29.09-05.10.2017

2.2.2 Cernavoda NPP

Between January and December 2017, 144 particle filters from the 12 monitoring locations were analysed by global alpha, global beta and gamma spectrometry measurements. No artificial radionuclides were detected from emissions from the Cernavoda NPP.

Table 2.3 - Ru-106 in aerosol samples taken in September 2017 at Cernavoda NPP fixed monitoring stations

Location	**Sampling interval**	**Volume of air sampled, (m^3)**	**Measured specific activity (Bq/m^3)**	**Measurement error, (Bq/m^3)**
ADI-02 Seimeni	05.09 - 05.10	403.032	3.39E-03	1.26E-03

ADI-03 Medgidia	07.09 - 05.10	400.033	3.39E-03	1.65E-03
ADI-04 Mircea Voda	05.09 - 05.10	434.519	3.10E-03	1.45E-03
ADI-05 Saligny	07.09 - 03.10	374.044	4.54E-03	1.56E-03
ADI-07 Fetești	06.09 - 06.10	432.12	3.18E-03	1.58E-03
ADI-09 Gherghina	06.09 - 04.10	434.369	5.34E-03	1.56E-03
ADB-01 Topalu	06.09 - 04.10	402.882	2.94E-03	6.51E-04

In September 2017, in the samples taken from 7 locations included in the Environmental Radioactivity Monitoring Program at Cernavoda NPP, the presence of the artificial radionuclide Ru-106 was identified, at a volume specific activity level of the order of mBq/m^3 . This radionuclide had not been identified in aerosol samples until that period and was also not detected in gaseous effluents from the plant. No other fission-produced artificial radionuclides, which could be generated by the technological processes of the plant, were identified in the environmental samples analysed.

The results of gamma spectrometry measurements of Ru-106 activity collected on particle filters are shown in Table 2.1. Specific activities were determined by relating the activity measured on the filter to the total volume sampled that month. RNSRM reported the presence of the artificial radionuclide Ru-106 in the air on the Romanian territory from 29 September to 3 October, therefore the estimated average concentration based on the sample collected during the environmental monitoring programme at the Cernavoda NPP is underestimated. On the basis of the results obtained by RNSRM, which show that the radioactive cloud crossed the Cernavoda area on two days, 29 and 30 September, the average concentrations were calculated by correcting the volume of air sampled and the resulting values are presented in Table 2.3. The results obtained at the Cernavoda NPP are in good agreement with the results obtained by RNSRM, which show an average concentration of 64.2 mBq/m^3 .

As can be seen from Figure 2.7, the results of the global beta activity measurements of the September air samples also show an increase in the order of mBq/m^3 .

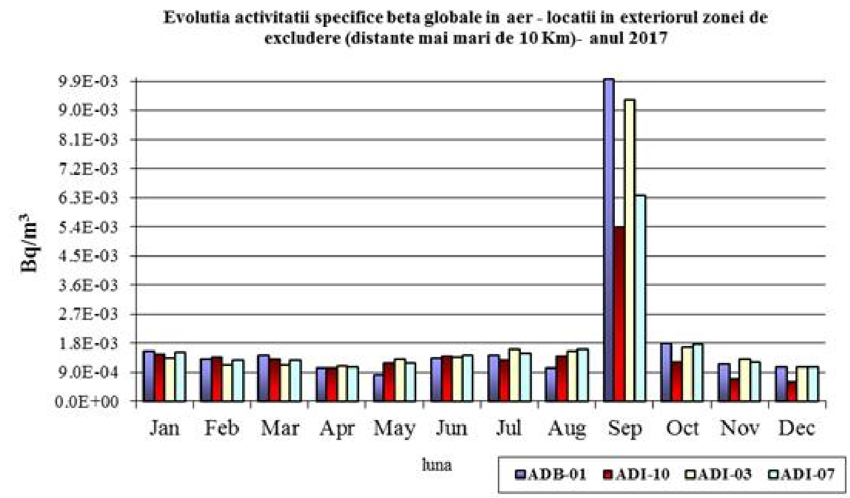


Figure 2.7. Overall beta activity of air samples taken in 2017

2.2.3 ICN Pitesti

None of the measurements described in paragraph 2.1.3 led to the detection of Ru-106 in the samples taken. However, Ru-106 was subsequently detected in some of the spontaneous vegetation samples taken in November 2017 as part of the environmental radioactivity monitoring programme, its concentration being at levels close to the detection limit of the methods used.

Table 2.4 shows the results of the monitoring of the Ru-106 content of aerosol samples taken in the period immediately after 03.10.2017. In none of the samples taken could Ru-106 be detected. For both aerosol samples the minimum detectable activities (MDA) of Ru-106 were determined, under filter measurements with a spectrometer system with HPGe detector having a relative efficiency of 21% and a spectrum acquisition time between 60000 and 100000 s. The minimum detectable concentrations were also calculated for one-hour samplings (MDC* Ru-106) and for the actual samplings (MDC Ru-106) performed with the two sampling systems.

Table 2.4. Ru-106 monitoring results in aerosol samples from ICN

Sampling system	Sampling period	Sampling flow rate (mc/h)	MDA Ru-106 (Bq/p)	MDC* Ru-106 (mBq h/mc)	MDC Ru-106 (mBq/mc)
Portable pump	03.10.2017 20:30 - 09.10.2017 10:20	1.32	0.5	378.8	2.8
Monitoring station	03.10.2017 20:30 - 04.10.2017 08:30	25	0.4	16.0	1.3

If it is taken into account that in the absence of a continuous emission source, radioactive contamination in the form of aerosols is present in the air at a given location for a relatively short period of time (when the contaminated air mass crosses the location), then a long-term sampling will not allow a correct assessment of the level of air contamination, but can only be used to highlight the presence of this contamination during the sampling interval. In the case of short-term sampling, the sampling rate should be as high as possible to achieve the best detection sensitivity. If the airborne contaminant concentration profile is to be obtained, the sampling interval length should be chosen in relation to the release duration (e.g. one tenth of the release duration), but also taking into account the detection limit of the method for the chosen sampling interval. Also, consideration should be given to the large number of samples that may result from monitoring with short sampling intervals, which will require a long measurement interval.

The atmospheric deposition sample was taken between 20.09 - 04.10.2018, in the premises of ICN Pitesti, using an atmospheric deposition collector with a surface of 0.5 m^2 . The sample was measured with a spectrometric system with HPGe detector having a relative efficiency of 21% and a spectrum acquisition time of 70000 s. Ru-106 could not be detected in the deposition sample, the detection limit being 2.75 Bq/m^2 .

Table 2.5 presents the results of Ru-106 measurements from spontaneous vegetation samples taken in November 2017 from a number of monitoring locations included in the environmental radioactivity monitoring programme of ICN Pitesti.

Although in most of the samples the Ru-106 concentration was below the detection limit, where - concentration values were indicated, this radionuclide could be highlighted by the presence in the gamma spectrum of the 621.91 keV line sample of its Rh-106 progeny.

Table 2.5 Ru-106 measurement results from spontaneous vegetation samples at ICN

Code of evidence	Ru-106 activity concentration (Bq/kg)	MDC (Bq/kg)	Sampling location
I1	2.78 +/- 0.75	2.34	Wastewater treatment plant-ICN
I2	-	3.70	Town of Mărăcineni - Colibași Bridge
I3	2.92 +/- 1.27	4.11	Village Făgetu
I4		5.50	Purcăreni Village - Doamnei River
I5	1.34 +/- 0.60	1.92	Village Piscani - River Targului
SVE1	2.35 +/- 1.11	3.58	City of Mioveni, in the area of the houses on Buceag Street
SVE2	-	5.10	NE end of DACIA platform
SVE3	-	3.74	Near the ICN - Mioveni road at a distance of 1150 m from the reactor stack
SVE4	-	5.15	Along the ICN road - Wastewater treatment plant at a distance of 1150m from the reactor stack
SVE5	1.83+/- 0.95	3.08	Near ICN road - sewage treatment plant 100 m upstream from the station
F1	2.34 +/- 0.55	1.70	Village Conțești
C1	-	6.00	Pitesti - Arges Bridge

Ru-106 concentration values in Table 2.5. below the minimum detectable concentration (evaluated with the Currie algorithm for 95% confidence level) were reported to indicate the presence of the radionuclide of interest in the samples. According to the statistical theory underlying the assessment of the limit of detection, in this situation the measurement results indicate detection with 95% confidence of the presence of the radionuclide Ru-106 in the sample, but they are not statistically significant enough to state with 95% confidence that the concentration values of Ru-106 are higher than the calculated MDC. At the same time it should be noted that the detection limit of the measurement method used for atmospheric deposition was relatively high (2.7 Bq/m^2) which means that the presence of Ru-106 in the deposition samples is not excluded, but at such low levels that it was not detectable by the analytical methods used. Thus, the non-detection of Ru-106 in deposition samples cannot exclude the possibility of its detection in vegetation samples.

3. Public communication

Under the terms of Romanian law, which are in accordance with the terms of specific international standards, the presence in the environment on the national territory at the end of September 2017 of elevated concentrations of the isotope Ru-106 from an external source did not represent an emergency situation.

The presence of elevated concentrations of Ru-106 in the European area has at no time constituted a potential emergency situation. However, at the international level, against the background of real concerns among both specialists in organisations with responsibilities for monitoring national spaces and segments of the public in European countries that have detected the presence of Ru-106, important components of international collaboration and communication in radiological emergency situations have been activated by the IAEA in its relations with Member States. At the international level, the need was to address possible concerns arising from the lack of knowledge of the source of the emission and the high uncertainties about the possibility of locating the source by the means and methodologies used in the international system.

Even if there was no potential emergency condition, without elucidating the source of the Ru-106 release, i.e. the cause of the release, the public perception that there was a risk factor in this event cannot be dispelled. In these circumstances, the authors considered it appropriate to provide a clear and concise presentation of the way in which public communication was carried out by the Romanian authorities.

For this event the authorities in their communication strategy have identified three communication targets, namely:

- risk communication in the media to the general public,
- inter-institutional communication and
- communication with the international community

The main objective set during this communication event was to clarify the situation both within the country to national decision makers and to the international community and also to effectively communicate the risk because the perception of radiological risk by the population is a risk factor in event/crisis management. Risk perception is considered as the difference between how risk is perceived by the general public and how risk is assessed and measured by experts.

Usually an assumption gets public perception wrong. The public needs to understand that the technical assessment is correct without considering the various factors on which the public perception and risk assessment are based. In fact, the objective of risk communication is not to reinforce an exchange of differing opinions between experts and the public, rather it is to develop a common understanding so that each opinion is taken into account. Trust and availability of information are key elements of risk communication.

3.1. Media communication to the public

The general public has very little knowledge and a large number of uncertainties when it comes to events/situations involving radioactive materials/artificial radionuclides. This can be attributed to a large number of factors. This area of expertise is not easily accessible to the general public. At the same time, however, for example, the effects of a nuclear accident are very well known. Lack of knowledge shows us that most people are dependent on the positions of experts or information communicated in the media.

The main purpose of the communication during this event was to avoid creating confusion among the public that could cause unfounded reactions or even panic. This aim was also fully justified by the fact that, over time, the Romanian public, especially through the press trusts, has expressed concerns following the appearance of information/speculations in the international or Romanian media and also on social media about the unjustified presence of radioactivity in the environment.

The public communication was carried out by CNCAN through press statements given by the President of CNCAN to various press trusts, as well as through CNCAN's press releases on the subject, which can be found at the following address on the official website of this institution: http://www.cncan.ro/informatii-de-interes-public/comunicate-si-conferinte-de-presa-arhiva/.

CNCAN press releases provided information to the public that addressed key issues regarding this event, such as:

- the cooperation between CNCAN and ANPM, regarding the detection of Ru- 106 in the air on the Romanian territory from 29 September to 3 October 2017 and the public information made by CNCAN;
- how CNCAN collaborates with national organisations with detection and measurement capabilities;
- clarifications that the source of the detected Ru-106 was not from the territory of the country and that the presence of Ru-106 on the territory of Romania was not detected after 3 October 2017;
- the reasoning behind the higher levels of Ru-106 detected in Romania;
- the way CNCAN collaborates with ANPM and the joint reporting by these key national institutions in the monitoring and reporting of environmental radioactivity on national territory to the IAEA Vienna;

- how CNCAN collaborates with organisations outside the country that have remote release dispersion analysis and inverse modelling capabilities in order to reconstruct the areas from which Ru-106 could have been released considering a ground release.

At the same time, ANPM responded to requests for information received from national and international (Moldovan) media.

Inter-institutional communication

The organisations in Romania with legal responsibilities for the effective monitoring of environmental radioactivity, which had direct information and informed CNCAN, as the public institution authorised at national level to communicate such information to the public on the identification of elevated concentrations of anthropogenic radionuclides in the environment on the territory of Romania, were ANPM, which is also the national authority with responsibilities for RNSRM, and the holders of CNCAN licences operating major nuclear and radiological facilities in Romania: CNE Cernavoda, IFIN-HH and ICN Pitesti.

The public communication rule addressed by these organisations for the event was to provide information to CNCAN and the environmental authorities within the framework of the collaboration protocols, which are signed by each organisation with these institutions and/or in response to additional requests from these authorities for measurement data and additional information, without providing any public communication of their own.

By addresses sent on 04.10.2017, 06.10.2017 and 01.11.2017, respectively, ANPM informed national decision-makers about the identification of the presence of the artificial radionuclide Ru-106 in atmospheric aerosol samples, as well as further developments.

3.3. Communication with the international community

From 3-6 October 2017, several IAEA Member States in Europe voluntarily reported through their national emergency contact points to the IAEA Incident and Emergency Centre (IEC) information that low concentrations of Ru-106 were detected in large volumes of air samples at levels well below those requiring public protection actions.

In the face of increased interest from Member States, the IAEA created an event under the title "Ru-106 Measurements in Europe" in the Unified System for Information Exchange in Incidents and Emergencies (USIE), where it published all the information that has been provided by Member States in the European region at its request since 08.10. 2017.

For use by Member State authorities only, the IAEA published Incident and Emergency Centre (IEC) reports under the title 'Status of Ru-106 Measurements in Europe,' which included *key information on*: *presentation of the status of the situation that created the event, information related to measurement results or event-related information reported by Member States, technical data on Ru-106, the lack of need for protective action, and assessment of the current situation*.

Note that the USIE is an IAEA web portal for Member State Contact Points under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, as well as for officials nominated as INES National Officers to post for events rated using the International Nuclear and *Radiological* Event Scale (INES).

It can be said that in the communication with the international community on the Ru-106 event, two pillars of communication were dominant:

- the communication made by CNCAN to the international community through the IAEA's USIE, which was based on the procedures for notification in case of radiological incidents and emergencies and on the information exchanged with Member States and international organizations, transmitting two information reports made with the support of ANPM in the first report and ANPM and CNE Cernavoda in the second report by providing Ru-106 measurement data

- communication carried out by CNCAN and ANPM with ASN and IRSN in order to carry out a technical study to evaluate the Ru-106 measurement data obtained by the organisations in order to determine the possible location and probable magnitude of the source and to understand the process that could have been at the origin of the release of Ru-106 alone.

As for the second pillar, it is representative of the collaboration with international organisations, but at the same time it is important to point out that it was carried out at the request of French organisations.

The Institute for Radiation Protection and Nuclear Safety (IRSN) has publicly communicated on its website since November 2017 reports on the investigations made following the detection of traces of Ru-106 in monitoring sites on French territory and in sites with a wide European spread. It can be said that this is a good practice in terms of public communication by the French authorities, with reports and information from IRSN being immediately taken up in the ASN's own public communication and by other French nuclear organisations with an impact on French and international public opinion (e.g. the French Nuclear Energy Society- SFEN).

At the time of writing, investigations into the Ru-106 event are being carried out by an international commission initiated by the Institute of the Russian Academy of Sciences (IBRAE) and consisting of international experts from Russia, Germany, France, Finland, Sweden, Norway and the UK. The information provided by the reports of this commission, as well as in the public releases available on the websites of the organisations of the countries that nominated experts for this commission, will contribute to a complete information of the European public.

3. Conclusions

As the sequence of events mentioned in the report unfolded, the major conclusion regarding the activities carried out, namely the Ru-106 measurements, the assessments of the impact on the population and the environment and the reaction of the Romanian authorities, occurred after the event in question. The inter-institutional communication actions officially started after CNCAN received a request from the IAEA to carry out Ru-106 measurements on the national territory.

At the time of the Ru-106 measurements on the national territory, the Romanian institutions were not aware of the values already measured by other international organisations and also did not have immediate access to the discussions and exchange of information already existing in the international community on Ru-106 detection and measurements.

The event did not pose a risk to the population and the environment in Romania, as Ru-106 concentrations were very low, exceeding the detection limit of the equipment only on 5 days (29.09- 03.10.2017).

The monitoring results did not reveal the presence of any other man-made radionuclides, which is why the possibility of a nuclear reactor accident is excluded. In addition, the comparison of the results obtained by RNSRM with the results obtained at the Cernavoda NPP environmental laboratory leads to the conclusion that the Ru-106 cloud passed through the Cernavoda area on two days, 29 and 30 September, and demonstrates that the operation of the Cernavoda NPP did not involve the release of Ru-106 into the environment.

After Romania informed the international community about the measured values, it was found that these values were the highest values measured (hundreds of milliBequerels) by the European states' organizations. The automatic reaction of the international community was to turn its attention to Romania and ask if something had happened in Romania, if there had been an accident. Following measurements and assessments it was shown that the discrepancies in values were explainable because:

- The sampling and measurement strategy and method used by ANPM is deferred to other organisations
- ANPM took samples just during the Ru-106 cloud movement, probably just when the maximum values were reached, with measurements being taken 5 days after the sampling date.

Given the extremely low values of Ru-106 in ambient air, its presence could not be detected by immediate analyses, both global beta (laboratory analysis) and total gamma (via automated stations), and it is practically masked by natural radioactivity, mainly radon and its progeny, whose atmospheric values peak in autumn.

The detection and identification by RNSRM of the presence of Ru-106, at trace level, in the ambient air over the territory of Romania, together with the other European laboratory networks, demonstrated on the one hand the capacity of the network to respond promptly to particular situations that may arise, but also the effectiveness of the monitoring strategy implemented, through screening and stepwise analysis of samples. In practice, the presence of contamination in the ambient air has been detected by global beta analyses every 5 days (this is a cheap, fast and above all reliable way of screening data). It should be noted that the situation was not singular in Romania, but on the contrary it was generally valid for all the monitoring networks made up of automatic stations and laboratories in Europe, whose data were reported on the common EURDEP platform and which in turn did not register any variation in the range of results obtained for the immediate analyses. As in Romania and other European countries, the presence of Ru-106 was detected by laboratories measuring at trace level.

A particular problem that can lead to immediate wrong conclusions is the way in which laboratories in European countries collect and report the data analysed. Comparison of results obtained by laboratories in Europe, which in the absence of a harmonised procedure at European level, apply individual strategies and methods of analysis, has led to initial wrong assumptions that Romania could be the polluter.

The monitoring strategy applied by RNSRM made it possible to track at hourly intervals how the pollutant cloud penetrated, crossed and then left the national territory. The data obtained were presented as such to all national and international decision makers (IAEA). Following the information reported in the international media, it emerged that Romania had the shortest time for data collection and integration (5 hours for sampling and 11 - 24h for integration/spectrometric gamma analysis, compared to sampling intervals generally weekly), thus being able to demonstrate, with concrete data, that the pollution identified has a source other than Romania.

The non-detection of Ru-106 in deposition samples cannot exclude the possibility of its detection in vegetation samples. This is based on the results of Ru-106 measurements in spontaneous vegetation samples taken in November 2017 from a number of monitoring locations included in the environmental radioactivity monitoring programme of ICN Pitesti. Further study would be possible and also necessary to establish, with a certain level of confidence, the applicability range of the monitoring methods used and the ranges of values in which results obtained by different methods can serve for the mutual validation of results.

The lack of direct and immediate communication with the international community and the non-participation of the responsible organisations in Romania in international expert groups such as *Ring of Five the European network of experts* led to Romania being suspected as the source of the pollution, a suspicion that lasted for more than half a year, until international analyses and assessments indicated the possible source of the Ru-106 pollution.