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Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

BULGARIA
Sofia

Routine and emergency radioactivity monitoring arrangements
Monitoring of radioactivity in drinking water and foodstuffs

13-15 November 2018

Reference: BG 18-02

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES	Routine and emergency radioactivity monitoring arrangements Monitoring of radioactivity in drinking water and foodstuffs
LOCATIONS	Sofia, Bulgaria
DATES	13-15 November 2018
REFERENCE	BG 18-02
TEAM MEMBERS	Mr V. Tanner (team leader) Ms F. Tzika
REPORT DATE	15 April 2019
SIGNATURES	

V. Tanner F. Tzika

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Abbreviations

CBRN	Chemical, Biological, Radiological, Nuclear
EEA	Executive Environmental Agency
EURDEP	EUropean Radiological Data Exchange Platform
GM	Geiger-Müller
HPGe	High-purity Germanium
IAEA	International Atomic Energy Agency
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
INRNE	Institute for Nuclear Research and Nuclear Energy
JRC	Joint Research Centre
LIMS	Laboratory Information Management System
MAFF	Ministry of Agriculture, Food and Forestry
MH	Ministry of Health
MOEW	Ministry Of Environment and Water
NCRRP	National Centre of Radiobiology and Radiation Protection
NIMH	National Institute of Meteorology and Hydrology
NRA	Nuclear Regulatory Agency
NSEM	National System of Environmental Monitoring
RAW	Radioactive Waste
RHI	Regional Health Inspectorate
RIEW	Regional Inspectorates of Environment and Water
WHO	World Health Organisation

TECHNICAL REPORT

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with basic safety standards[1]. Article 35 also gives the European Commission the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The Joint Research Centre Directorate-General provides technical support during the verification visits and in drawing up the reports.

The main purpose of the verifications under Article 35 of the Euratom Treaty is to provide an independent assessment of the efficiency and adequacy of monitoring facilities for:

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways;
- levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified Bulgaria of its decision to conduct an Article 35 verification in a letter addressed to the Bulgarian Permanent Representation to the European Union. The Nuclear Regulatory Agency (NRA) was designated to lead the preparations for the visit.

2.2 DOCUMENTS

To assist the verification team in its work, the national authorities supplied an information package in advance[3]. Additional documentation was provided during and after the verification visit. The information provided was used as a source during drawing up the descriptive sections of the current report.

2.3 PROGRAMME OF THE VISIT

The Commission and the NRA discussed and agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006.

The opening meeting included presentations on Bulgaria's National Automated System for Continuous Control of the Radiation Gamma Background (BULRAMO) and other environmental

1 Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (OJ L 13, 17.1.2014)

2 Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006)

3 Replies to the preliminary information questionnaire addressed to the national competent authority, received on 19 October 2018

radioactivity monitoring arrangements. The verification team pointed to the quality and comprehensiveness of all the presentations and documentation.

The team carried out the verifications in accordance with the programme in Annex 1. It met the following representatives of the national authorities and other parties involved:

Name	**Organization**	**Role**
Petar Dragoev	MOEW	Chief Expert in Environmental evaluation and Environmental impact assessment
Kosyo Voychev	EEA	Principal Expert, Environmental Monitoring Directorate
Kalinka Stoyanova	EEA	Head of Laboratory for Radiological Measurements, Laboratories and Analytical Activities, General Directorate
Stanislava Stoyanova	EEA	Junior expert, Environmental Monitoring Directorate
Elitsa Maneva	EEA	Principal Expert, Laboratory for Radiological Measurements, Laboratories and Analytical Activities, General Directorate
Teodora Todorova	MH	Director of Health Control Directorate
Iliya Tasev	MH	Chief Expert in Health Control Directorate
Magda Periclieva-Gueho	NCRRP	Deputy Director of the NCRRP
Rositza Kamenova-Totzeva	NCRRP	Head of Public Exposure Monitoring Laboratory
Desislava Dragancheva	RHI	Sofia Head of Health Control Unit, Public Health Directorate
Lidia Katzarska	NRA	State inspector in Radiation Protection Directorate
Ilcho Mitev	NRA	Chief Inspector in Radiation Protection Directorate
Ludmila Simeonova	NRA	Acting Head of Emergency planning and preparedness section
Blagorodka Veleva	NIHM	Head of Group “Radiometric measurements and chemistry of precipitation”
Todor Barzilov	DG FSCP-MoI	Head of National Operational Center

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING

3.1 LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

In Bulgaria, the following legal texts regulate the monitoring of radioactivity in the environment:

- Environmental Protection Act (SG No. 91/ 25.09.2002)
- Water Act (SG No. 67 / 27.07.1999)
- Health Law (SG No. 70 of 10.08.2004)
- Act on the protection of agricultural lands (SG No. 35 / 24.04. 1996) - Decree of the Council of Ministers No. 74/27.03.1998 on the liquidation of the consequences from the extraction and processing of uranium raw materials (SG No. 39/07.04.1998).
- Regulation № 1 on the limit values for the purposes of radiation protection and safety during liquidation of the consequences of the uranium industry in the Republic of Bulgaria (SG No. 101/23. 11. 1999.)
- Regulation on the conditions and the procedure for carrying out environmental impact assessment of investment proposals for construction, activities and technologies (SG, No. 25/18.03.2003)
- Regulation № 6 on the Limit Values for Admissible Contents of Dangerous and Harmful Substances in the Waste Water Discharged in the Water Bodies (SG, No. 97 / 28.11. 2000)
- Regulation № 9 on the Quality of Water Intended for Human Consumption (SG, No. 30/ 28.03. 2001)
- Regulation № 12 of 2002 on the quality requirements to surface waters Intended for Human Consumption (SG No. 63 of 28.06.2002)
- Regulation № H-4 for characterizing of surface waters (SG No. 22 of 15.03.2013)
- Regulation № 1 on the Exploration, Use and Protection of Groundwater (SG No. 87 of 30. 10.2007)
- Regulation № 18 on the quality of water for irrigation of agriculture crops (SG, No. 43 of 9.06. 2009)
- Regulation № 25 on the requirements for protection of the persons from chronic exposure as result from the production, trade and use of raw materials, products and goods with increased content of radionuclides (SG, No. 64 of 5.08.2005)
- Regulation for radiation protection (SG No. 16 of 20.02.2018)
- Act on the safe use of nuclear energy (SG No. 63 of 28.06.2002, last amendment 2018)
- Measurements Act (SG No. 46 / 7.05.2002)
- Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (SG No. 94 / 29.11.2011)
- Decree of the Council of Ministers № 85/17.04.2007 on the organization and coordination of the European Union issues (SG. No.35 of 27.04.2007)
- Regulation № 28 on the conditions and procedures for medical insurance and on individual's health protection norms in case of radiation accident (SG No. 84/2006)

3.2 LEGISLATIVE ACTS REGULATING RADIOLOGICAL SURVEILLANCE OF FOOD

In Bulgaria, the following legal texts regulate the monitoring of radioactivity in food:

- Food Law (SG. No. 90 of 15.10.1999)
- Council Regulation (EC) No 733/2008 of 15 July 2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station (OJ L 201, 30.7.2008)

3.3 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below includes the Euratom and the European Union legislation and the main international standards and guidance that form the basis for environmental radioactivity monitoring and the radiological surveillance of foodstuffs and feeding stuffs.

The Euratom and the European Union legislation

- The Euratom Treaty
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom
- Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption
- Council Decision 87/600/Euratom of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency
- Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety
- Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90
- Council Regulation (EEC) No 2219/89 of 18 July 1989 on the special conditions for exporting foodstuffs and feedingstuffs following a nuclear accident or any other case of radiological emergency
- Council Regulation (EC) No 733/2008 of 15 July 2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Council Regulation (EC) No 1048/2009 of 23 October 2009 amending Regulation (EC) No 733/2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Regulation (EC) No 1609/2000 of 24 July 2000 establishing a list of products excluded from the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Regulation (EC) No 1635/2006 of 6 November 2006 laying down detailed rules for the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Implementing Regulation (EU) 2016/6 of 5 January 2016 imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station and repealing Implementing Regulation (EU) No 322/2014
- Commission Communication Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty –– Practical arrangements for the conduct of verification visits in Member States
- Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole

- Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation
- Commission Recommendation 2003/274/Euratom of 14 April 2003 on the protection and information of the public with regard to exposure resulting from the continued radioactive caesium contamination of certain wild food products as a consequence of the accident at the Chernobyl nuclear power station

International legislation and guidance documents, issued mainly by the International Atomic Energy Agency (IAEA)

- *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna, 2014
- *Clearance of materials resulting from the use of radionuclides in medicine, industry and research*, IAEA-TECDOC-1000, IAEA, Vienna, 1998
- *Generic models for use in assessing the impact of discharges of radioactive substances to the environment*, Safety Reports Series No 19, IAEA, Vienna, 2001
- *Handbook of parameter values for the prediction of radionuclide transfer in temperate environments*, Technical Reports Series No 364, IAEA, Vienna, 1994
- *Management of radioactive waste from the use of radionuclides in medicine*, IAEA-TECDOC-1183, IAEA, Vienna, 2000
- *Regulatory control of radioactive discharges to the environment: Safety Guide*, Safety Standards Series No. WS-G-2.3, IAEA, Vienna, 2000
- *Sources and effects of* ionizing *radiation*, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000, Report to the General Assembly, Vol. I, United Nations, New York, 2000
- World Health Organisation (WHO), *Guidelines on the quality of drinking water (Guidelines for drinking-water quality*, 4th ed. 2011)

International Conventions

- Convention on Nuclear Safety
- Convention on Early Notification of a Nuclear Accident
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

4 BODIES HAVING COMPETENCE IN RADIOACTIVITY MONITORING

4.1 MINISTRY OF ENVIRONMENT AND WATER

The Ministry of Environment and Water (MOEW) carries out the state policy for environmental protection. According to the Law on protection of the environment, the state policy for environmental protection is integrated into sectoral policies – transport, energy, building works, agriculture, tourism, industry, education etc., and it is carried out by the Minister of environment and water and the competent bodies of the executive. The system of competent bodies on environmental protection includes:

- Environmental Executive Agency (EEA)
- Regional Inspectorates of Environment and Water (RIEW)
- Basin Directorates
- National Parks Directorates

The MOEW monitors the state of the environment on the territory of the country, issues orders, permits, instructions and manages the National System of Environmental Monitoring (NSEM) through the EEA. It issues jointly with the executive bodies standards for maximum permissible emissions, for maximum permissible concentrations of harmful substances by environmental components and for rational use of renewable and non-renewable natural resources, and endorses methods for environmental impact assessment. The Regional Inspectorates of Environment and Water, the Basin directorates and the National Parks Directorates ensure the pursuance of the state policy on environmental protection at regional level. Their number, territorial scope, activity, functions and structure are determined with rules issued by the MOEW.

4.1.1 Environmental Executive Agency

The Environmental Executive Agency (EEA) is an administration under the MOEW, which performs assessment and information functions on the control and protection of the environment in Bulgaria. It is a national reference centre within the European Agency on Environment. The Agency is led by an Executive Director and it is organized in 5 directorates:

- Monitoring and assessment of the environment
- Laboratory and analytical activity
- Permit regimes
- Finance, Legal Services, Administration and Human Recourses
- Information Systems, International Cooperation and Public Relations

The Agency is entrusted with the design and management of the National System of Environmental Monitoring (NSEM), which includes the following national monitoring networks:

- radiological monitoring
- noise “pollution” in the environment
- air
- rainfalls and surface waters
- underground and sea waters
- geological medium, earth and soils
- forests, protected territories and biological diversity
- depots and old waste contaminations

The network of EEA laboratories performing radio-analytical work consists of a central laboratory in Sofia and seven regional laboratories. All the EEA laboratories are accredited according to ISO/IEC 17025 by the EA BAS[4]. Typically, there are about 800 environmental samples analysed for

[4] Executive Agency Bulgarian Accreditation Service

radioactivity in the central laboratory and 100-150 environmental samples in the regional ones annually. The central laboratory and the regional laboratories participate in proficiency tests and inter-laboratory comparison exercises (IAEA ALMERA and EC JRC).

4.2 MINISTRY OF HEALTH

The Ministry of Health (MH) manages the national health care system and controls the activities for the protection of citizens' health and state health control. The state health policy on the territory of the Sofia district is implemented and organized by the Regional Health Inspectorates (RHI). The RHI's carry out on the territory of the respective district the activities related to the state health control, monitoring the factors of the living environment and the activities with importance for the health of the population. Through its specialised units, the Ministry carries out specific functions in the field of healthcare while using nuclear energy and ionising radiation. Such specialised units are the National Centre of Radiobiology and Radiation Protection (NCRRP), as well as the Radiation Control Departments at the Regional Health Inspectorates. State health control for compliance with the requirements for protection of persons from the impact of ionizing radiation is carried out by the RHI's designated by the Minister of Health (Burgas, Varna, Vratsa, Plovdiv and Rousse) and by the NCRRP. For the Sofia district, the state health inspectors in the NCRRP carry out the observance of the requirements for the protection of the persons from ionizing radiation.

The Ministry of Health ensures compliance with the principles of radiation protection through:

- control of the factors of the working and living environment for the purpose of defining and reducing the exposure of persons from sources of ionizing radiation;
- medical observation of persons working with sources of ionizing radiation;
- dosimetry control for defining the internal and external exposure of persons working with sources of ionizing radiation, assessment of the exposure and the radiation risk for the population as a whole or of a representative person;
- medical observation of persons exposed to sources of ionizing radiation during medical examinations and treatment;
- medical provision of the public in cases of radiation accident.

4.2.1 National Centre of Radiobiology and Radiation Protection

The National Centre of Radiobiology and Radiation Protection (NCRRP) carries out the state health and radiation control in nuclear facilities and at the sites of the former uranium mining industry on the territory of the whole country, as well as in facilities with sources of ionizing radiation on the territory of Sofia (Stolichna district) and the districts of Sofia, Pernik, Kustendil and Blagoevgrad. NCRRP is responsible also for the radiological monitoring in the living environment around nuclear facilities, as well as for the radionuclides content in drinking water, food and building materials on the territory of Sofia and the districts of Sofia, Pernik, Kustendil and Blagoevgrad.

NCRRP is structured in specialized units in compliance with the main activities in the field of radiobiology, radiation protection, radiation control, medical radiological protection and training and information activities. The Department for Radiation Protection laboratories (Public Exposure Monitoring Laboratory and Radiation Expertise and Radon Monitoring Laboratory) together with the Radiation Control Department organize the monitoring of the radiation in the living environment for the purposes of assessment of the public exposure as a whole and of the representative person. The department carries out the following:

- Monitoring of the public exposure from natural and increased radiation background and assessment of the radiation risk;
- Analysis of the radioactive substance content in environmental samples;

- Monitoring and control of the content of radioactive substances in consumption goods, relevant for the population health (drinking water, food, building materials);
- Monitoring of the radiation background in Sofia.

4.3 NUCLEAR REGULATORY AGENCY

In Bulgaria, the state regulation of the safe use of nuclear energy and ionizing radiation and of the safe management of radioactive waste (RAW) and spent fuel is carried out by the Nuclear Regulatory Agency (NRA), which is an independent specialised body of executive power. The NRA performs the following functions:

- Grant, amend, supplement, suspend or revoke licences and permits for safe conduct of the use of nuclear energy and sources of ionizing radiation.
- Supervise compliance with the requirements and standards for safe use of nuclear energy and ionizing radiation, radioactive waste management and spent fuel management.
- Commission the conduct of expert examinations, research and studies associated with nuclear safety and radiation protection in the use of nuclear energy and ionizing radiation and in radioactive waste management and spent fuel management.
- Interact with the executive authorities vested with competence to perform regulatory and control functions in the field of use of nuclear energy and ionizing radiation, and submit to the Council of Ministers measures for coordination of such activities.
- Implement the international cooperation of the Republic of Bulgaria in the field of safe use of nuclear energy, ionizing radiation, and safety of radioactive waste management and spent fuel management.
- Provide to individuals, legal persons and state authorities objective information on nuclear safety and radiation protection.
- Submit annually to the Council of Ministers a report on the state of nuclear safety and radiation protection in the use of nuclear energy and ionizing radiation and in radioactive waste management and spent fuel management, as well as on the other activities of the Agency.
- Organize and coordinate the drafting, and submit to the Council of Ministers, reports in compliance with the national obligations under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
- Perform the functions of a competent authority and a point of contact responsible for notification of an accident and for provision of assistance according to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.
- Provide the information required by the Treaty establishing the European Atomic Energy Community (Euratom) to the competent institutions.
- Perform the functions of a competent authority and point of contact within the European Community Urgent Radiological Information Exchange (ECURIE) system.
- Draft and submit to the Council of Ministers for adoption regulations on ASUNE and propose instruments amending and supplementing the regulations, where this is necessary for improvement of the statutory requirements, taking into account operating experience, the lessons learnt from safety analyses, and the advances in science and technology.

All the NRA regulations, annual reports and other relevant documents are published at the NRA website[5] (also in English).

4.4 National Institute of Meteorology and Hydrology

The National Institute of Meteorology and Hydrology (NIMH) is an independent standing scientific unit and a publicly funded legal person. It performs activities as a national hydro-meteorological authority of the Republic of Bulgaria and fulfils the international obligations of Bulgaria towards the World Meteorological Organisation (WMO).

NIMH monitors the background and trans-boundary air pollution and atmospheric radioactivity. Atmospheric radioactivity has been monitored at NIMH since the end of the 1950s in response to nuclear weapons tests. In addition, the institute develops atmospheric transport modelling systems for radiological emergency situations.

4.5 Institute for Nuclear Research and Nuclear Energy

The Institute for Nuclear Research and Nuclear Energy is an independent scientific unit and a publicly funded legal person. It carries out research on fundamental and applied projects in the field of elementary particles and nuclear physics, high-energy physics and nuclear energy, radiochemistry, radioactive waste treatment, monitoring of the environment and nuclear instruments development. The institute's staff is about 350 (150 of them scientific researchers) working in more than 30 research groups. The Institute has an atmospheric high-altitude observation post at the Mussala Mountain (altitude 2928 m), where for example radionuclides of the Fukushima accident plume were detected. Among other environmental studies, the institute has studied radioactivity in mineral water and wine.

[5] www.bnra.bg

5 RADIOACTIVITY MONITORING PROGRAMMES

5.1 ENVIRONMENTAL EXECUTIVE AGENCY

5.1.1 Introduction

In Sofia, there are no facilities with sources of ionizing radiation that could have impact on its environment. In the vicinity (about 30 km) of the city there is a facility for temporary storage of low and intermedium level RAW and some cultivated tailing ponds of former uranium mining and milling facilities, which were shut down almost 30 years ago.

The MOEW through the EEA and the Radiation Measurement Laboratories (Sofia, Vratsa, Montana, Pleven, Varna, Bourgas, Stara Zagora and Plovdiv) performs monitoring of the radiation status of the environmental components in Bulgaria. The radiological monitoring consists of:

- Continuous measurements of equivalent dose H*(10) by the National Automated System for Continuous Control of the Radiation Gamma Background (BULRAMO). The BULRAMO system has 26 Local Monitoring Stations (LMS) located throughout the country; one of these stations is located in Sofia.
- Periodic automatic sampling of atmospheric aerosols at stations in Bourgas, Varna, Vratsa, Montana, Pleven and Sofia and subsequent gamma-spectrometric analysis for determination of volume specific activity of natural and artificial radionuclides.
- Periodic monitoring of uncultivated soils - soils are sampled and analysed once a year (0-20 cm of topsoil) at 32 points, four of which are on potential pollutant areas (areas of former uranium mining sites). At each point, also the natural gamma background is measured.
- Periodic monitoring of surface and groundwater - once a year 26 samples from Sofia and the Sofia region are analysed. Radiochemical analysis is performed to determine total α and β radioactivity; when exceeding the threshold values, the amount of natural uranium and ^{226}Ra are measured.
- Periodic monitoring of sediments - 21 sediment samples from Sofia and the Sofia district are analysed annually to determine the radioactivity concentration of natural and artificial radionuclides.

The results of the radiological monitoring of the environmental components (quarterly and annual reports) are published on the website of the EEA[6].

5.1.2 Automatic monitoring of external gamma dose rate

The MOEW through the EEA maintains the National Automated System for Continuous Control of Radiation Gamma Background (BULRAMO). The automated system is designed to take into account the specificity of the existing nuclear facilities, the location of the larger cities and the borders with the neighbouring countries. The main purpose of the BULRAMO system is:

- Continuous monitoring of the gamma radiation background level throughout the country and the storage of the information in a database.
- Early notification in the event of an increase in the gamma radiation background due to an emergency or nuclear weapon conflict.
- Submitting operational information to the relevant state authorities.
- Issuance of bulletins and reports on the gamma background for the public.
- Submitting operational information to the European Radiological Data Exchange Platform (EURDEP) (since 2004).

[6] http://eea.government.bg

BULRAMO consists of 26 local monitoring stations (Fig. 1) with higher concentrations around the Kozloduy NPP, in the bigger cities and at the borders of the country. Each Local Monitoring Station (LMS) consists of:

- intelligent gamma-probe (IGS 421B-H Envinet GmbH- Germany)
- rain detector (RD 203 Envinet GmbH - Germany)
- data logger
- communication equipment
- public display

Spectrometer gamma probes (SARA IGS710/910 Envinet GmbH) are installed in 16 of the 26 LMS. Two of the SARA gamma spectrometer stations employ $LaBr_3$ detectors; 14 stations use NaI(Tl) detectors.

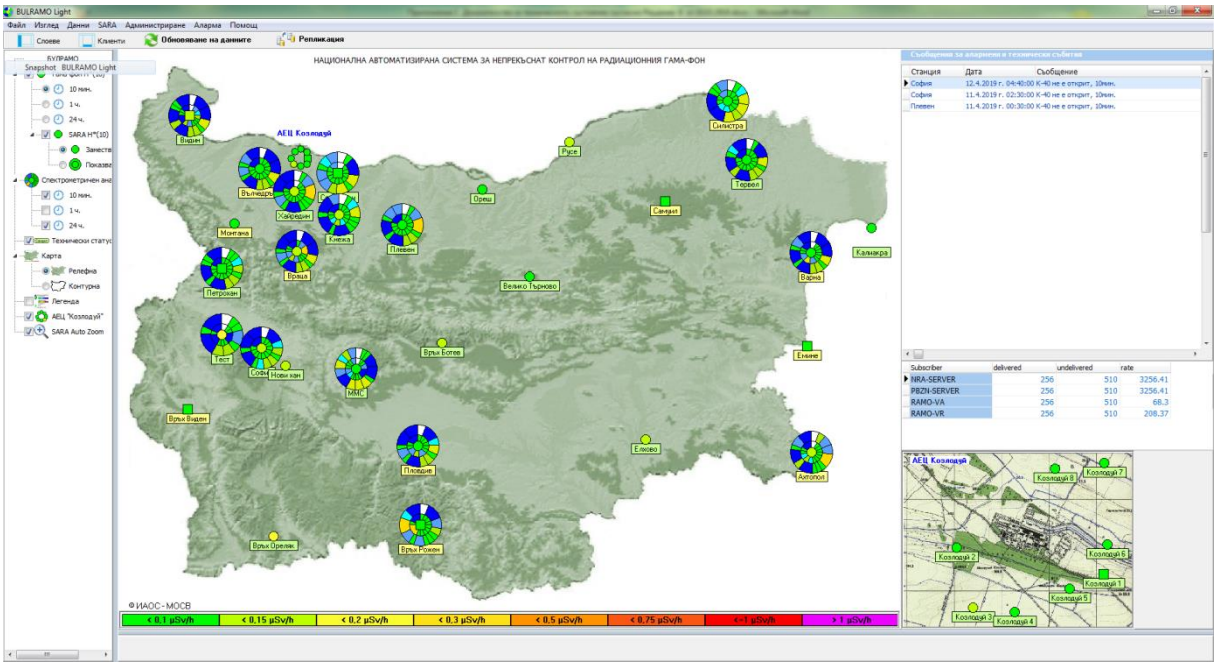

Figure 1. BULRAMO network

A general upgrade of the BURLAMO system took place in 2013-2014 with ENVINET equipment. In Fig. 2 one of the LMS equipped with a gamma spectrometric probe is shown. The main measure is 10-minute average gamma dose rate. Once every 10 minutes, the data via an IP/VPN (3G/GPRS) network is transmitted to the Control Center located in the building of the EEA in Sofia. The functions of the Control Center are:

- Collecting and processing data from the LMS network and storing them in a database
- Display of information about the gamma radiation background
- Remote configuration of LMS parameters
- Emergency alarm

The data is stored in a MS SQL Server, where, on the basis of the 10-minute average values obtained from the LMS, the mean one-hour and average daily values for gamma background are calculated. Users (Supplementary Monitoring Centres) of the BURLAMO system are:

- Ministry of Interior (Civil Protection)
- NRA
- EEA - RL Varna/ Vratsa
- Kozloduy NPP
- EC JRC - Ispra (EURDEP system)

Figure 2. Envinet SARA automatic radiation monitoring station with a control source ring

5.1.3 Monitoring of radioactivity in air

Monitoring of radioactivity in aerosols is carried out in the Sofia Radiation-Analytical Laboratory of the EEA, which uses the following automatic sampling devices:

- Sampling at station "Nadezhda" (Fig. 3), equipped with a device types VOPY-10 and GAS-model EDL, 300WE, on 8 x 10 inch (20.3 x 25.4 cm) glass fiber filters, flow rate 10 m³/h;
- Sampling at station "Buhovo" and "Yana", equipped with a device FH 95 using glassfiber filters with a diameter of 47 mm, flow rate 1 m³/h.

The apparatus are located in thermally insulated containers. There is a standard stand in which electronic and pneumatic elements and an electrically heated tubing system for sample feeding with an integrated membrane and a filter holder are installed. The software package allows to determine the desired speed and volume of air flow passed through the filter as well as the sampling time. The sampling takes 5-7 days for the points Bourgas, Varna, Vratsa, Montana (total air volume 1600 m³) and 14 days for Nadezhda station in Sofia (total air volume 3000 m³).

At the analytical laboratory, the air filter is measured by gamma-spectrometry using a Canberra system with a semiconductor HPGe detector. Volume specific activities of ^{238}U, ^{226}Ra, ^{228}Ra, ^{40}K, ^{210}Pb, ^{137}Cs and ^{7}Be are determined. The counting time is 60 - 96 hours. The filters from the Buhovo and Yana stations are also measured for total beta radioactivity.

Figure 3. High volume air sampling container in Nadezhda, Sofia, for atmospheric radioactivity monitoring

5.1.4 Monitoring of radioactivity in water

Surface waters

Radiological monitoring of the rivers in Sofia and the Sofia region is carried out through a network of sampling points for the characterization of surface water. The water samples are analysed for determination of total alpha and total beta radioactivity, the natural uranium content and specific activity of ^{226}Ra. The surface waters of the following rivers are analysed:

- Maritsa river at Kostenets
- Milkyovska river before the river Privna
- Lesnovska River near the Dolni Bogrov village
- Kremikovska River
- Iskar river near the village of Vlado Trichkov

Water samples from the districts of the former uranium mining sites are also analysed.

Ground water

For Sofia and the Sofia region, ground water from a sampling borehole in the Gabra site is taken once a year. For the analysis, 1 litre water sample is required.

Water samples are analysed for total alpha activity and total beta activity in the Radiation Measurement Laboratory of the EEA. For the analysis, 1 litre water sample is required. A calibrated low-level alpha-beta counter with 6 proportional gas flow detectors (type FHT 770 T6 Thermo-Scientific) is used.

5.1.5 Monitoring of radioactivity in soil

In Sofia and the Sofia district, samples of uncultivated soil at 32 points (sampling depths 0-20 cm) are collected once a year. At each collection point, the equivalent gamma dose rate is measured using a portable dosimeter type FH 40 G-L. Soil samples and sediments are sampled according to BDS EN ISO 18589-2:2018. Samples are prepared for gamma-spectrometry analysis by drying, grinding and homogenizing. In the Radiation Analytical Laboratory the samples are analysed by gamma spectrometry to determine the specific activities of ^{238}U, ^{226}Ra, ^{232}Th, ^{40}K, ^{137}Cs and ^{210}Pb.

5.1.6 Mobile monitoring systems

The EEA has a mobile monitoring system (Mobile laboratory), which is a part of the national automated system for monitoring the radiation background, intended for emergency response situations. It can be placed anywhere in the country and connected to the BULRAMO central station. The mobile station is equipped with standard technical equipment, as a local monitoring station of the national system.

5.1.7 Information to the general public

The public has access to the radiation information produced by the EEA through the following:

- Daily newsletter (http://eea.government.bg/bg/output/daily/bulletin-rad.html)
- EURDEP web site & EURDEP widget http://eurdepweb.jrc.ec.europa.eu/EurdepMap/Default.aspx
- Quarterly bulletin http://eea.government.bg/bg/dokladi/threemonth/threemonth.02_2018/index
- National Report on the Status and Protection of the Environment in the Republic of Bulgaria http://eea.government.bg/en/output/soe-report/index.html

5.2 National Centre of Radiobiology and Radiation Protection

5.2.1 Introduction

Radiological monitoring in Sofia is a part of the NCRRP monitoring program for assessing the doses of internal exposure by ingestion of radionuclides (drinking water, food, air, dust) and external exposure from the environment. The NCRRP performs its own sampling from the living environment. Samples are measured for the determination of significant radiological risks or radionuclides content required by the regulations. The scope and frequency of radiological monitoring are regulated by orders of the Ministry of Health. The orders also include the type of samples to be analysed, as well as the radionuclides to be determined in the relevant samples.

The Department for Radiation Protection of the NCRRP (Public Exposure Monitoring Laboratory and Radiation Expertise and Radon Monitoring Laboratory) together with the Radiation Control Department organize the monitoring of the living environment for the purposes of assessment of the public exposure as a whole, and of the representative person. This is done by:

- Monitoring of the public exposure from natural and increased radiation background and assessment of the radiation risk;

- Analysis of the radioactive substances content in environmental samples, mainly the content of artificial radionuclides and artificially increased content of natural radionuclides;
- Monitoring and control of the content of radioactive substances in consumption goods, relevant for the population health (drinking water, food, building materials);
- Monitoring of the radiation gamma background in Sofia (a point for continuous high-precision measurement of the ambient equivalent dose rate on the territory of the NCRRP).

The NCRRP laboratories are part of the Inspection body type A, accredited by the Bulgarian Accreditation Office Executive Agency in compliance with BDS ENISO/IEC 17020:2012:

- The Radiation Expertise and Radon Monitoring Laboratory carries out monitoring of the radiation factors of the working environment in facilities, which have obtained a license by the NRA for nuclear facility operation, and of the radiation factors of the living environment in the vicinity of facilities of the former uranium mining and uranium processing industry in Bulgaria, as well as radon content determination in the living environment.
- The Public Exposure Monitoring Laboratory is responsible for sampling and laboratory analyses of samples from the living environment (water, air, soil, sediments, mixed diet, vegetation, and atmospheric deposition) as well as for providing the laboratory radiological analyses. Sampling of drinking water (tap water and ground water for the state health control) is done by the Regional Health Inspectorates.
- The Department Radiation Control together with the Public Exposure Monitoring Laboratory are in charge of food sampling. Sampling is done from the market once a year and includes sampling of all ingredients of public diet. Pasteurized milk is sampled monthly and mixed diet quarterly.

5.2.2 Monitoring of external gamma dose rate

The NCRRP performs continuous gamma dose rate measurements using a Berthold Technology gamma dose rate meter of type 70045 A. The raw data are recorded using a computer allowing for their tracking over time, identifying trends, and setting up an average background.

For the precise measurements of ambient dose the NCRRP has Victoreen®451P and 451P-DE-SI Ion Chamber Survey Meters. These radiometers can detect beta radiation energy above 1 MeV and gamma ray energy above 25 keV. In addition, there are other instruments available in the NCRRP for radiation dose rate monitoring (Dosimeterradiometer MKS-05 “TERRA” and Multi-purpose Survey Meter RADOS RDS 110).

5.2.3 Monitoring of radioactivity in air

NCRRP has one air particulate filter sampler produced by F&J Speciality Products INC, Model No FHV-1 DSF. The sampler has the possibility to sample from 8.5 to 84.95 m^3/h with 4 % uncertainty. The device is portable; it is used in routine monitoring in Sofia as follows:

- 2 times per year (NCRRP building)
- 2 times per year (INRNE-BAN)
- 2 times per year (villages Novi Han, Krushovica and Gabra, situated near nuclear repository Novi Han about 25 km from Sofia)

The device samples particulate matter in air - the NCRRP has no capability to monitor gaseous radioactivity in air (Iodine).

5.2.4 Monitoring of radioactivity in atmospheric deposition

The NCRRP has an atmospheric deposition collector situated on the balcony of its building. The device is a stainless steel vessel with collection area of 0.1772 m^2 (volume 100 l). The bottom of the

vessel is covered with Vaseline. The sampling is done quarterly. Gross alpha radioactivity, gross beta radioactivity, radioactivity content of ^{90}Sr and artificial gamma emitters (mainly ^{137}Cs) are measured.

5.2.5 Monitoring of radioactivity in water

Surface waters

NCRRP and RHI Sofia do not monitor radioactivity in surface waters in Sofia. Monitoring of surface water is not an obligation of the structures under the MH. NCRRP monitors radioactivity in surface water only for the purpose of dose assessment near nuclear facilities. The closest points to Sofia are situated near the nuclear waste repository Novi Han (rivers flowing through villages Novi Han, Krushovica and Gabra). The sample volume is 45 L and the sampling frequency twice per year. Gross alpha activity, gross beta activity, ^{90}Sr activity and artificial gamma emitters (mainly ^{137}Cs) are measured.

Ground water and drinking water

NCRRP and RHI Sofia do not monitor radioactivity in ground water in Sofia. Monitoring of ground water is not an obligation of the structures under the MH.

Sampling for drinking water is done by the Sofia Regional Health Inspectorate. The volume of samples is 7 L. The RHI Sofia provides the NCRRP with the samples for radiological analysis. NCRRP performs the analysis and gives estimates of the total indicative dose. Upon receipt of the results, the NCRRP provides the outcome reports with results, health conclusions and recommendations included. Based on this protocol, the RHA decides to follow up and, if necessary, take administrative measures.

Radon monitoring in drinking water is carried out by the NCRRP (sampling and analysis). In addition, for the purposes of the implementation of Article 35 of the Euratom Treaty, the NCRRP carries out its own quarterly drinking water sampling for ^{90}Sr and ^{137}Cs determination.

5.2.6 Monitoring of radioactivity in soil

The NCRRP monitors radioactivity in soil as follows:

- once a year at the NCRRP new building and at the NCRRP repository old building;
- once a year at the INRNE-BAN;
- twice a year at the villages Novi Han, Krushovica and Gabra, situated near the nuclear repository Novi Han at about 25 km from Sofia.

0-12 cm depth of soil is sampled with a borer. The amount of the sample is about 3 kg. The samples are analysed for determining the activities of gamma emitters and ^{90}Sr.

5.2.7 Monitoring of radioactivity in terrestrial flora

The NCRRP monitors radioactivity in vegetation as follows:

- once a year at the NCRRP new building;
- once a year at the INRNE-BAN;
- once a year at the villages Novi Han, Krushovica and Gabra, situated near the nuclear repository Novi Han, at about 25 km from Sofia.

Sampling is carried out using scissors. Gamma emitters and ^{90}Sr are assessed.

5.2.8 Monitoring of radioactivity in food

The NCRRP carries out radiological surveillance of food in Sofia by monitoring the content of radioactive substances in consumption goods relevant for the population health (milk, mixed diet and different foodstuffs). The results for milk and mixed diet are reported to the EC REM database. The aim of the monitoring is to estimate the doses for the public. RHIs in Plovdiv, Vratsa, Ruse, Burgas and Varna carry out the same monitoring on their territories. RHIs report data to the MH and NCRRP.

Milk

Inspectors from the NCRRP, together with staff from PEML of NCRRP, take samples of pasteurized milk from the market, aiming to sample different brands each time. The samples are measured for determination of radioactivity of gamma emitters and ^{90}Sr, as well as gross beta activity and gross alpha activity.

Mixed diet

24 h menu is sampled at the Children Paediatric Hospital quarterly each year. Gamma emitters, ^{90}Sr, gross beta activity and gross alpha activity are assessed.

Foodstuffs

The following foodstuffs are sampled once a year:

- fish trout - 3 kg
- pork - 2,5 kg
- chicken meat - 2.5 kg
- veal - 2,5 kg
- lamb - 2,5 kg
- baby dry milk - 3 packs of 300 g
- baby vegetable paste - 2 kg
- baby fruit puree - 2 kg
- baby puree with meat - 2 kg
- child mash - 1 kg
- rice - 3 kg
- flour - 4 kg
- mature beans - 3 kg
- lentils - 3 kg
- potatoes - 4 kg
- apples - 3 kg
- onions - 3 kg
- bananas - 3 kg
- tomatoes - 3 kg
- carrots - 3 kg
- fresh milk (four different brands of fresh or pasteurized milk) - 2 l
- dry milk - 1 kg
- sheep's cheese - 2.5 kg;
- cow cheese - 2.5 kg
- cow's milk cheese - 2.5 kg
- sheep's milk cheese - 2,5 kg
- nuts - forks - 2 kg
- nuts - mix - 2 kg
- cooking salt from Ukraine - 2 kg
- wild mushrooms - fresh or frozen (2 kg) or dried (500 g).

Gamma emitters, ^{90}Sr, gross beta activity and gross alpha activity are assessed.

5.2.9 Information to the general public

Information concerning radiation monitoring is provided by the NCRRP to the general public through two national reports: the National report for public health and the National report for the status of the environment[7]. The RHI provides to the population up-to-date information on the state of drinking water in the city of Sofia twice a month via the inspection website[8].

[7] http://www.ncrrp.org/new/bg/Informatsiya_za_naselenieto-c193

[8] https://srzi.bg/bg/vodi

5.3 NATIONAL INSTITUTE OF METEOROLOGY AND HYDROLOGY

5.3.1 Monitoring of radioactivity in air and atmospheric deposition

The National Institute of Meteorology and Hydrology (NIMH) operates four regional radiometric laboratories placed in Sofia, Pleven, Varna and Burgas. Sofia is the central laboratory and the others function as regional ones. The monitoring equipment is identical in each laboratory. The following sampling (see Fig. 4 for sampling locations) and analysis are carried out:

- Each working day air filter samples are taken and measured for gross beta activity (immediately after sampling for short lived beta and after 24, 72 and 120 h for so called long lived beta activity). The total volume of sampled air varies from 30 to 100 m^3. If the total beta activity is above the set alarm levels, the samples are measured also for gamma emitting radionuclides using low-level gamma spectrometry.
- Atmospheric fallout samples are collected in a cylindrical sampling container (with collection area of 0.2 m^2). The sampling frequency varies from 7 days to 1 month. The aliquot of the liquid sample is evaporated to dryness and measured by total beta counting. If needed, the sample can be measured also by low level gamma spectrometry.
- 24-hour planchet samples (exposure of cotton material to the atmospheric aerosols on horizontal plane surface at 1m above ground) are regularly collected. The sample is ashed and measured for beta radionuclides. Monthly samples are composed and measured by gamma spectrometry.
- 24-hour precipitation samples are collected in plastic containers. A 0.25 litre aliquot from each sample is evaporated and measured by total beta counting.

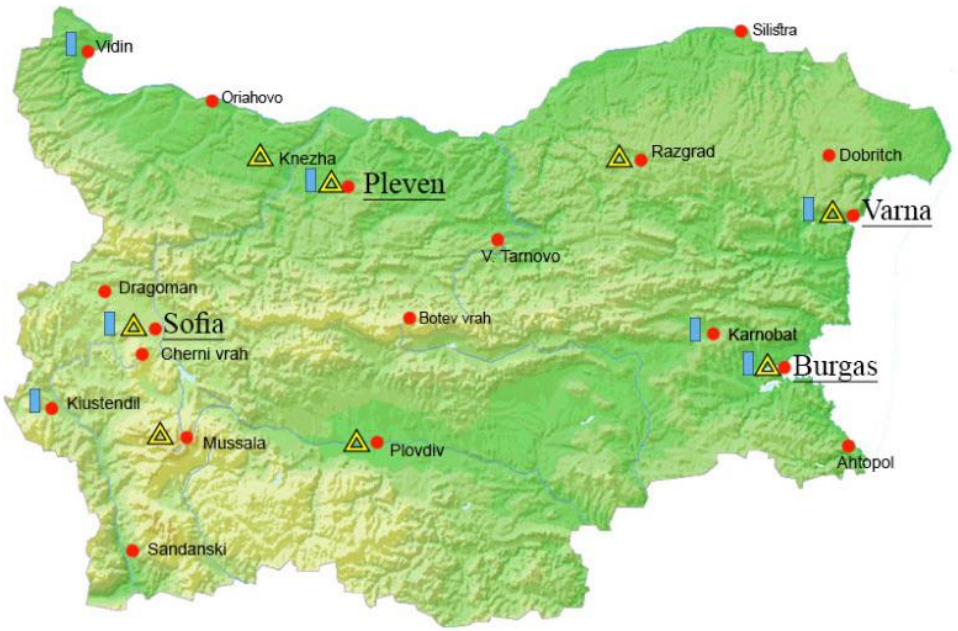

Figure 4. NIMH sampling locations

5.4 INSTITUTE FOR NUCLEAR RESEARCH AND NUCLEAR ENERGY

5.4.1 CBRN monitoring vehicle

The Institute for Nuclear Research and Nuclear Energy operates a CBRN monitoring vehicle (Fig. 5), which is equipped to carry out monitoring of chemical, biological, nuclear and radiological substances. This mobile laboratory has not yet an established role in the Bulgarian authorities' emergency preparedness arrangements.

Figure 5. CBRN monitoring vehicle

6 VERIFICATIONS

The verification team carried out the verification activities according to the agreed programme (Annex 1).

6.1 General Directorate Fire Safety and Civil Protection

6.1.1 Stand-by duty service

Stand-by duty (24/7) for emergency situations is maintained in the national crisis centre of the General Directorate Fire Safety and Civil Protection. The centre has direct communications with the Kozloduy NPP and it has access to the BULRAMO system data and alerts (alarm limit 300 nSv/h approximately). A daily bulletin is prepared for the general public.

In addition to the automatic monitoring, the General Directorate Fire Safety and Civil Protection maintains also a manual dose rate monitoring system, in which 28 regional civil protection centres measure radiation dose rate three times each day and report the results to the national operational centre.

The General Directorate Fire Safety and Civil Protection also operates the Bulgarian Early Warning and Alert System (public alarm sirens).

No remarks.

6.2 Nuclear Regulatory Agency

6.2.1 Mobile laboratory

The NRA operates a mobile laboratory built in a Mercedes-Benz Sprinter van. The laboratory is equipped with the following:

- Portable dose rate meter including 3 telescopic probes
- Two portable NaI based gamma ray spectrometers (Identifier including neutron dose rate meter and Canberra FieldSpec) for nuclide identification
- Sampling equipment for soil and water
- Meteorological monitors (wind speed, wind direction, temperature)
- Small volume air sampler (fibreglass filter)
- GPS system
- Electric generator for back-up power
- Personal protective equipment
- Crime scene sampling kit

The NRA has a possibility to carry out monitoring of the environment, but it is not considered a 24h emergency capability. Altogether 5 staff members have been trained for mobile monitoring. The laboratory equipment includes personal dosimeters for the monitoring staff.

No remarks.

6.3 National Centre for Radiobiology and Radiation Protection

6.3.1 Public Exposure Monitoring Laboratory

The NCRRP Public Exposure Monitoring Laboratory is a radiological laboratory with nine staff positions. During the verification, three of these positions were vacant. The laboratory carries out monitoring of radioactivity in the living environment, i.e. in air, deposition, food, mixed diet, water, soil and sediments. Monitoring programmes include a national programme, but also regional programmes around the Kozloduy NPP and the Novi Han repository; also commercial Radon analysis for private clients are carried out. The laboratory is accredited (ISO 17025) to carry out gamma spectroscopy and analysis of ^{226}Ra, ^{90}Sr, gross alpha/beta, ^{222}Rn in water, U_{nat} and ^{137}Cs in water.

Based on the results, the laboratory prepares dose assessments for the general public and representative persons in the regional programmes. In addition, internal dose assessments are prepared based on mixed diet monitoring. The number of analysed samples in about 1000 per year, 350-400 of them drinking water (provided by water suppliers).

The laboratory maintains its sample and measurement result records on paper logbooks, there is no LIMS system or barcodes. Sample coding system was presented to the verification team. Detailed written analysis instructions are available for the staff.

The verification team visited the laboratory facilities, which are spacious and clean. Rooms are allocated for different purposes as follows:

Water sample evaporation room

Water samples are concentrated by evaporation for four days before gross alpha/beta counting.

Balance room

The laboratory balances are kept in this room. External calibration service is used for scales every three years. In addition, there is an internal control procedure carried out once a year. Temperature and humidity records are maintained to ensure stable operating conditions.

Counting rooms

The laboratory equipment includes two gamma spectroscopy systems (only one working during the verification), a total alpha/beta counter and Radon monitors. An investment project is on-going to acquire an ICP-MS, a liquid scintillation counter and an alpha spectrometer. The laboratory counting equipment includes the following:

- Gross alpha/beta counters (2) – old Bulgarian manufacture (Low level activity system LAB 3A)
- Radon monitor (AlphaGuard with Aquakit) for water monitoring (can be used as a mobile device)
- Mobile small-volume air sampler (F&J, particulate filter, no iodine filter available)
- Gamma spectrometer (Ortec HPGe and DSpec)
- Alpha/beta counter (Thermo Scientific FHT770, 6 planchet positions)

The verification team noted that, although the gamma spectrometer efficiency calibration is carried out using a certified standard source, no sample density/matrix correction is used, which might introduce systematic errors in the analysis results when the sample material/matrix is different from the one of the standard source.

> *The verification team recommends that the Ministry of Health proceed to improve the laboratory equipment, in particular by acquiring a liquid scintillation counter, an alpha spectrometer and an additional gamma spectroscopy system.*
>
> *The verification team recommends that the Ministry of Health proceed to fill the vacant staff positions of the laboratory as soon as possible.*
>
> *The verification team recommends that the NCRRP introduce a computer-based sample and results handling system (LIMS) to replace the paper logbooks.*
>
> *The verification team recommends that the Public Exposure Monitoring Laboratory introduce a sample matrix correction algorithm to the gamma spectroscopy efficiency calibration procedure.*
>
> *The verification team recommends that the Public Exposure Monitoring Laboratory include monitoring of gaseous radioactive iodine in its monitoring capabilities available in a nuclear emergency situation.*

6.3.2 Radiation Expertise and Radon Monitoring Laboratory

The NCRRP Radiation Expertise and Radon Monitoring Laboratory is a radiological laboratory with six staff positions. It carries out monitoring of the various old uranium-mining sites in Bulgaria (water, sediment and soil from altogether 78 sites) and monitoring of Radon in buildings and workplaces. The laboratory is in proses of accreditation (ISO 17025) to carry out Radon measurements. Alpha-beta screening in waters from uranium mining sites is carried out on the basis of ISO 10704. For the precise measurements (when there is a need), the waters are measured by PEML under accreditation (ISO 17020).

The laboratory maintains its sample and measurement result records on paper logbooks as well as in electronic form; there is no LIMS nor sample bar-coding systems. Sample coding system was presented to the verification team. Detailed written analysis instructions are available for the staff.

Laboratory facilities are spacious and clean. Rooms are allocated for different purposes as follows:

Radiological laboratory room

The room is used for sample preparation, gross alpha/beta counting and total-U determinations. The number of samples is about 100 samples/year. The equipment consists of a spectrophotometer Zuzi model 4201/20 (total-U determination) and Thermo Scientific RadEye HEC gross alpha/beta counter.

Radon laboratory

The Radon laboratory room is equipped with a RODUSIS-system for and an E-PERM system for indoor radon determination. The E-PERM system can be used also for radon in water measurements, but the analysis time is very long (up to three days). The laboratory analyses 70-100 samples per year.

The laboratory participates in annual intercomparison exercises. The latest intercomparison results showing excellent performance of the laboratory were presented to the verification team.

> *If the number of annual samples increases, the verification team recommends that the NCRRP introduce a computer-based sample and results handling system (LIMS) at the Radiation Expertise and Radon Monitoring Laboratory.*

6.4 Executive Environmental Agency

6.4.1 Atmospheric radioactivity monitoring station

The Executive Environmental Agency has one medium volume air radioactivity monitoring station in Sofia (“Nadezhda”); in addition, there are two other stations nearby the city ("Buhovo" and "Yana").

In the Sofia station, there are two sampling systems located in a heated container. The first system has a filter air volume of about 3000 m^3 in the two-week sampling interval (10 m^3/h). The system is equipped with a particulate filter and a calibrated flow controller. The second system is based on a medium volume sampler (F&J Specialty Products), where the airflow can be directed to go through either a small particle filter or in the event of an emergency through an iodine sampling cartridge. The air volume is about 600 m^3 in 12 days sampling interval (2 m^3/h). The switchover form particle to iodine sampling needs to be done manually.

The measurement container is equipped with an UPS system for 6 hours autonomous operation.

> *No remarks.*

6.4.2 Laboratory for radiological measurements

The Executive Environmental Agency has 15 regional laboratories (7 have gamma spectrometry and 6 ICP-MS capabilities). In addition to being the regional laboratory for Sofia, the Sofia laboratory acts as a control laboratory, which receives about 5% of the samples analysed for radioactivity in the regional laboratories for control purposes. The laboratory has a staff of six. It analyses surface water, ground water, sediments, soil and air filters.

Laboratory facilities are well suited for their purpose. The counting room is equipped with three Canberra HPGe gamma spectrometry systems, one with an automatic sample changer. Efficiency calibration is done for each measurement geometry (Marinelli, small and large filter papers) using commercial standards. Regular controls of system energy, efficiency and resolution (FWHM) are carried out. EFFTRAN software is available for calculating density/matrix or geometry corrections for calibrations. There are also comparison exercises among the regional laboratories.

The laboratory has also a spectrophotometer for total uranium analysis and an alpha/beta counter (Thermo Scientific FHT 77T) for air filter analysis. In addition, the laboratory has one of the two Liquid Scintillation Counters in Bulgaria (Quantulus) for Tritium analysis, three AlphaGuard systems and an E-PERM system for radon in air and water (not accredited for the latter method) monitoring.

The EEA laboratory participates in IAEA ALMERA and EC JRC proficiency tests. Samples are kept for one year after analysis.

The verification team noted that only the sample location is noted on the sampling sheet, not sample number or sampling time.

> *The verification team suggests that the EEA ensures that the sampling documentation is precise enough to ensure sample traceability also in situations where the number of samples increases.*

> *The verification team commends the impressive number of gamma spectrometry systems available for environmental monitoring in Bulgaria.*

6.4.3 Early warning system data centre

The data centre of the BULRAMO system is located at the EEA headquarters. The system is based on Envinet SARA stations, which measure radiation dose rate, temperature and precipitation (yes/no). Radiation energy spectrum for nuclide identification is also available in most stations. Data are transferred via GPRS; radio modems of the old system are used as back-up.

On each station, the radiation dose rate measurement is done with three GM-tubes: two for low dose rates and one for high dose rates. On 16 stations, there is also a SARA gamma spectrometer for radiation energy spectrum measurement. Two of these stations use $LaBr_3$ detectors and 14 stations use NaI(Tl) detectors. In addition to the fixed stations (26 in total), there is one mobile station including a SARA probe available for location on-site in the event of an emergency.

Data is displayed on an interactive map (Fig. 6), which allows the user to see the contribution of different nuclides in the total dose rate on several confidence levels (counting time). Data is polled every 10 minutes and transferred to the EURDEP system every hour. The alarm level is 2.5 – 3 times the annual average dose rate value. Detection sensitivity of each detector is controlled once a year using a standard source.

> *Verification team commends the innovative solutions in the BULRAMO system graphical dose rate display.*

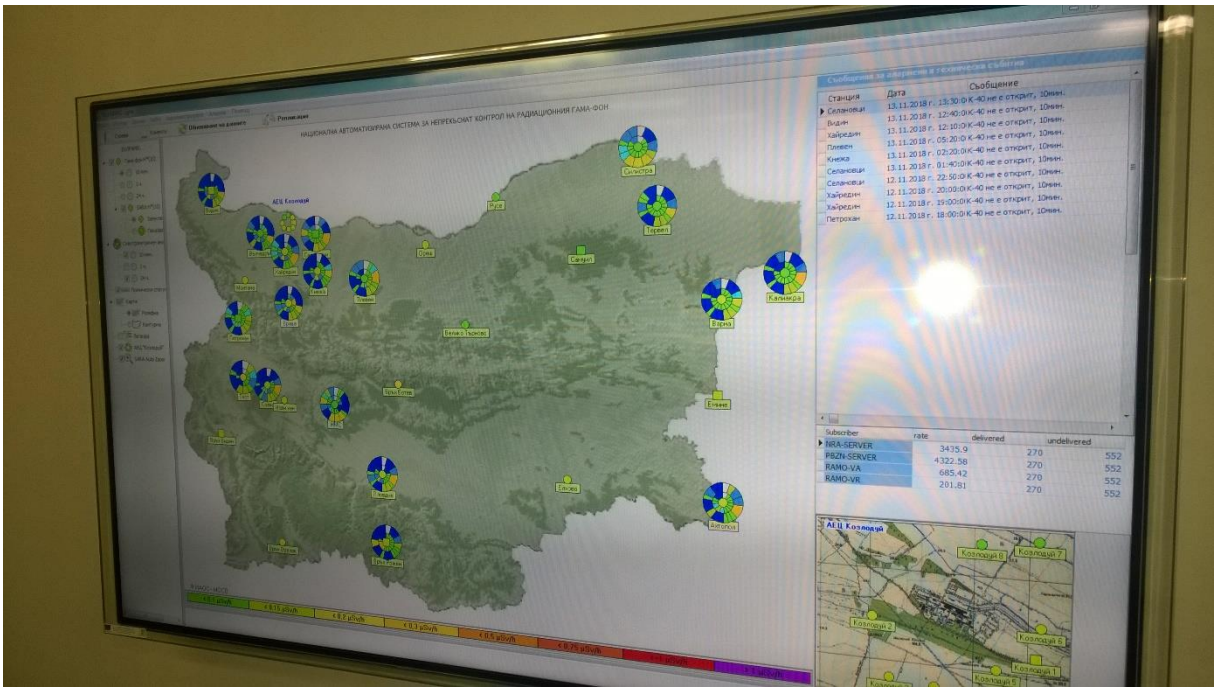

Figure 6. BULRAMO interactive dose rate map display

6.5 National Institute of Meteorology and Hydrology

6.5.1 Sampling for atmospheric radioactivity monitoring

The radioactivity sampling equipment of the NIMH is located in a fenced meteorological monitoring garden among other meteorological instruments. Verification team verified the equipment for collecting wet and dry atmospheric deposition (Fig. 7).

No remarks.

6.5.2 Laboratory

The NIMH radiological laboratory analyses the wet and dry deposition samples collected at the meteorological garden. It is equipped with the following instruments:

- radiometers VAV 20040 with plastic scintillators (3)
- Alpha spectrometer Ortec Octete
- Low-level gas proportional radiometric system RISOE 25-5
- Dose meters Berthold LB 133 and Beta/gamma dose meter MKC -07

The equipment is old, but functional and suitable for the purpose. The laboratory has difficulties in finding qualified staff; typically, there are only 1-2 persons available to work on radioactivity measurements.

The verification team recommends renewal of the laboratory counting equipment in the near future.

Figure 7. Atmospheric dry deposition sampler and a precipitation collector at the NIMH

6.6 INSTITUTE FOR NUCLEAR RESEARCH AND NUCLEAR ENERGY

6.6.1 Mobile CBRN laboratory

The Institute for Nuclear Research and Nuclear Energy maintains a mobile CBRN laboratory van (Fig. 5) and auxiliary equipment (including a decontamination tent). The verification team was informed, that the laboratory radiation monitoring equipment includes the following:

- EXATEL portable gamma spectrometer (NaI detector for nuclide identification)
- EXATEL RAB-M surface contamination meter with GPS mapping
- EXATEL SLR gamma dose rate meter
- EXATEL SLR neutron detector
- Telescopic probe
- Swipe sampling equipment
- Electronic personal dosimeters (4)

The unit is equipped with an external power connection and a diesel generator for long-term autonomous operation. Three persons have been trained by the Institute to carry out mobile monitoring activities.

The unit is not yet part of the official emergency organisation in Bulgaria. The Civil Protection Service has 28 similar units.

> *In order to maintain long-term operation during a radiological emergency, the verification team recommends that the Institute for Nuclear Research and Nuclear Energy increases the number of staff trained to carry out mobile monitoring.*

7 CONCLUSIONS

All planned verification activities were completed successfully. The information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, proved very useful.

The information provided and the verification findings gave rise to the following observations:

(1) Overall, the environmental radioactivity monitoring programmes in Sofia comply with the requirements of Article 35 of the Euratom Treaty.

(2) The verification activities found that the facilities needed to carry out continuous monitoring of levels of radioactivity in air, water and soil in Sofia are adequate. The Commission ascertained that these facilities are in operation and running efficiently.

(3) The verification activities found that the facilities needed to carry out monitoring of levels of radioactivity in the air, water and soil in the event of a radiological emergency in Sofia are adequate. The Commission ascertained that these facilities are continuously available.

(4) A few recommendations have been formulated. They concern in particular laboratory equipment, calibration procedures and staffing. Notwithstanding these recommendations, the verified parts of the monitoring system for environmental radioactivity in Sofia are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(5) The team's recommendations are set out in detail in the 'Main Conclusions' document addressed to the Bulgarian competent authority through the Bulgarian Permanent Representative to the European Union.

(6) The Commission services kindly request the Bulgarian authorities to submit, before the end of 2020, a progress report on how the team's recommendations have been implemented and on any significant changes in the set-up of the monitoring systems. Based on this report the Commission will consider the need for a follow-up verification in Bulgaria.

(7) The verification team acknowledges the excellent cooperation it received from all people involved in the activities it undertook during its visit.

ANNEX 1

VERIFICATION PROGRAMME

EURATOM ARTICLE 35 VERIFICATION IN BULGARIA (SOFIA)

13 – 15 November 2018

Tuesday 13 November

09.00 Opening meeting
(Bulgarian Nuclear Regulatory Agency, 69 Shipchenski prokhod Blvd.)

- European Commission Art. 35 verification programme introduction
- Overview of environmental radioactivity monitoring arrangements in Bulgaria/Sofia
- Verification planning

13.30 Monitoring facilities

- Early warning system data centre
- Gamma dose rate monitoring system in Sofia
- High volume air sampler in Sofia
- NRA Mobile laboratory

Wednesday 14 November

09.00 National Centre of Radiobiology and Radiation Protection (NCRRP)
(3 Georgi Sofiiski Blvd.)

- Public Exposure Monitoring Laboratory

13.30 National Centre of Radiobiology and Radiation Protection (NCRRP)
(132 Sveti Kliment Ohridski Blvd.)

- Radiation Expertise and Radon Monitoring Laboratory

Thursday 15 November

09.00 Executive Environmental Agency (EEA)
(136 Tzar Boris III Blvd.)

- Laboratory for Radiological Measurements
- Mobile laboratory

13:30 National Institute of Meteorology and Hydrology (NIMH)
(66 Tzarigradsko shose)

- Atmospheric radioactivity monitoring
- Radiological laboratory

14:00 Institute for Nuclear Research and Nuclear Energy
(72 Tzarigradsko Chaussee)

- CBRN mobile laboratory