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DIRECTORATE-GENERAL FOR ENERGY

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Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

CZECH REPUBLIC

Prague

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

12 – 14 September 2023

Reference: CZ 23-04

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES	- Facilities for monitoring environmental radioactivity - Facilities for monitoring food and drinking water radioactivity - Associated analytical laboratories
LOCATIONS	- Prague and the surrounding area
DATES	12 – 14 September 2023
REFERENCE	CZ 23-04
TEAM MEMBERS	Mr Vesa Tanner, DG ENER (team leader) Mr Agris Ozols, DG ENER
REPORT DATE	22 February 2024
SIGNATURES	

V. Tanner A. Ozols

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Legend

Abbreviation	**Explanation**
AMS	Automatic monitoring station
ASLAB	The centre for the ASsessment of LABoratories
BWC	Biological Weapons Convention
ČEZ, a.s	NPP operator in the Czech Republic: Dukovany and Temelín
ČHMU	Czech Hydrometeorological Institute (*Český hydrometeorologický ústav*)
ČIA	Czech Accreditation Institute (*Český institut pro akreditaci*)
ČMI	Czech Metrology Institute (*Český metrologický institut*)
CVŘ	Research centre *Řež* (*Centrum výzkumu Řež*)
CWC	Chemical Weapons Convention
DIAMO	State enterprise (registered seat at Stráž pod Ralskem), an organisation dealing with elimination of consequences of mining activities after uranium, ore, and partially also coal mining in the Czech Republic
EC	European Commission
ECURIE	European Community Urgent Radiological Information Exchange
EPR	Emergency Preparedness and Response
EU	European Union
EURDEP	EUropean Radiological Data Exchange Platform
EWN	Early Warning Network
EWS	Early Warning System
GM	Geiger-Müller [detector]
GSM	Global System Mobile
HAW	High-active waste

Abbreviation	Explanation
HPGe	High-purity Germanium [detector]
IAEA	International Atomic Energy Agency
IAEA -TERC	IAEA Terrestrial Environmental RadioChemistry [laboratory]
IAEA-TEL	IAEA Terrestrial Environment Laboratory
ILAC	International Laboratory Accreditation Cooperation - organisation for accreditation bodies, involved in the accreditation of conformity assessment bodies
IRIX	International Radiation Information eXchange [data format]
JRC	Joint Research Centre
JRC-REM	JRC Radioactivity Environmental Monitoring
LabSys	Laboratory Information Management System (LIMS)
LLD	Lower limit of detection, aka detection limit (*cf*. ISO 11929)
LSC	Liquid Scintillation Counting
MDA	Minimum Detectable Activity, aka detection limit (*cf*. ISO 11929)
MonRaS	MONitoring of RAdiation Situation [database]
NaI	Sodium Iodide [detector]
NORM	Naturally occurring radioactive material
NPP	Nuclear Power Plant
PIPS	Passivated Implanted Planar Silicon [detector]
RC	Regional Centres [of SÚJB]
REM	Radioactivity Environmental Monitoring [database]
RMN	Radiation Monitoring Network
RW	Radioactive waste
RWDF	Radioactive waste Disposal Facility
SF	Spent [nuclear] fuel
SÚJB	State Office for Nuclear Safety (*Státní úřad pro jadernou bezpečnost*)
SÚJCHBO	National Institute for Nuclear, Chemical and Biological Protection (*Státní ústav jaderné, chemické a biologické ochrany*)
SÚRAO	Czech Radioactive Waste Repository Authority (*Správa úložišť radioaktivních odpadů*)
SÚRO	National Radiation Protection Institute (*Státní ústav radiační ochrany*)
SVÚ	State Veterinary Institute (*Státní veterinární ústav*)
SZPI	Czech Agriculture and Food Inspection Authority (*Státní zemědělská a potravinářská inspekce*)
TLD	Thermo-Luminescent Dosimeter [or – Dosimetry]
ÚJF	Nuclear Physics Institute [of Czech Academy of Sciences] (*Ústav jaderné fyziky Akademie věd České republiky*)
ÚJV (ÚJV Řež)	ÚJV Řež, a.s. – Nuclear Research Institute (*Ústav jaderného výzkumu*) partly owned by ČEZ
ÚKZUZ	Central Institute for Supervising and Testing in Agriculture (*Ústřední kontrolní a zkušební ústav zemědělský*)
VÚLHM	Forestry and Game Management Research Institute (*Výzkumný ústav lesního hospodářství a myslivosti*)
VÚV (VÚV TGM)	T.G. Masaryk Water Research Institute (*Výzkumný ústav vodohospodářský T.G. Masaryka*)
WPS	Web Presentation Server

TECHNICAL REPORT

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water, and soil and to ensure compliance with the basic safety standards[1]. Article 35 also gives the European Commission (EC) 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 EC's Joint Research Centre (JRC) 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 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 exposure 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 EC notified the Czech Republic of its decision to conduct an Article 35 verification in a letter addressed to the Permanent Representation of the Czech Republic to the European Union. The Czech Government subsequently designated the State Office for Nuclear Safety (SÚJB) to lead the preparations for this visit.

2.2 PROGRAMME OF THE VISIT

The EC and SÚJB agreed on a programme of verification activities (Annex 1) in line with the Commission Communication of 4 July 2006.

The opening meeting held at the SÚJB premises included presentations on the following:

- Commission Article 35 verification programme
- SÚJB introduction
- Environmental radioactivity monitoring in the Czech Republic

[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; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018 (OJ L 13 of 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, pp. 2-5)

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 of activities in Annex 1. It met the following representatives of the national authorities and other parties involved:

State Office for Nuclear Safety

- Ing. Karla Petrová, Head of Section for Radiation Protection
- Mgr. Ondřej Chochola, Dis., Head of Monitoring and Crisis Management Division
- Ing. Jan Varmuža, Radiation protection inspector
- Ing. Ondřej Kuklínek, Radiation protection inspector assistant

National Radiation Protection Institute

- Mgr. Ales Froňka PhD., Head of SÚRO
- Ing. Pavel Fojtík, Deputy for Radiation Protection
- RNDr. Petr Rulík, Head of Monitoring department
- Mgr. Michal Fejgl PhD., Head of Department of Radiochemistry
- Ing. Irena Češpírova, Head of Emergency Preparedness Department
- Ing. Petr Kuča, Head of Analytical Expert Group and EWN Department
- Ing. Miroslav Hýža, PhD., Head of Department of Spectrometry
- Ing. Daniela Ekendahl, Head of Department of Dosimetry

T.G. Masaryk Water Research Institute

- Ing. Barbora Sedlářová

3 RADIOLOGICAL MONITORING FRAMEWORK IN THE CZECH REPUBLIC

3.1 RADIOLOGICAL SITUATION IN THE CZECH REPUBLIC

Monitoring of environmental radioactivity in the Czech Republic is carried out in the context of an active national nuclear programme, several nuclear facilities in the neighbouring countries, localised ^{137}Cs contamination caused by the Chernobyl NPP accident and (in certain regions) high natural radon concentrations.

There are two nuclear power plants in the Czech Republic:

- Dukovany Nuclear Power Plant, which has four Russian-design pressurised water reactors of type VVER-440 V-213
- Temelín Nuclear Power Plant, which has two units of VVER-1000 V-320 type

There is one foreign nuclear power plant close to the Czech border: the Jaslovské Bohunice NPP (two reactors), located in the western part of the Slovak Republic.

The Dukovany NPP site also houses an Interim Spent Fuel Storage Facility, a Spent Fuel Storage Facility and a radioactive waste (RW) Disposal Facility for intermediate-level waste operated by the Czech Radioactive Waste Repository Authority (SÚRAO). At the Temelín site, there is also a Spent Fuel Storage Facility.

The SÚRAO operates the following other radioactive waste repositories in the country:

- RW Disposal Facility Hostim, close to Beroun (shut down)
- RW Disposal Facility (RWDF) Richard, Litoměřice
- RW Disposal Facility Bratrství, close to Jáchymov

Two nuclear research reactors (LVR-15 and LR-0) are operated by the research organisation Centrum Výzkumu Řež (CVŘ), located in the village of Řež near Prague:

- LR-0 research reactor is a light-water, zero-power, pool-type reactor with an operational power of 5 kW thermal.
- LVR-15 research reactor is a light water tank-type reactor placed in a stainless-steel vessel under a shielding cover. It has forced cooling, IRT-4M fuel and an operational power of 10 MW thermal.

The site in Řež also houses a high-active waste (HAW) Storage Facility, which is designed for storage of spent fuel (SF) and solid radioactive waste (RW) produced by ÚJV Řež, a.s., and CVŘ. The RW Management Facility of ÚJV Řež, a.s. is also located on this site. It is a RW treatment plant.

Furthermore, at Řež, several cyclotrons and particle accelerators are present:

- Cyclotron U-120M at Nuclear Physics Institute of Czech Academy of Sciences (ÚJF; multipurpose accelerator commissioned 1977 and modernised 2002)
- Cyclotron TR-24 at ÚJF (commissioned 2015, proton beams)
- Tandetron 4130MC at ÚJF

There are two research laboratories at Řež:

- ÚJV Řež, a.s., providing a wide range of services (support for the operating units and the preparation of new nuclear units, RW management, production of radiopharmaceuticals, and R&D activities for nuclear reactors, nuclear safety and reliability development of a deep geological repository in the Czech Republic, *etc.*)
- Nuclear Physics Institute of the Czech Academy of Sciences (ÚJF).

There is also a third research laboratory using open sources in the country: the Czech Metrology Institute (ČMI), whose laboratories are located in Prague and headquarters in Brno.

The Czech Technical University in Prague operates a research reactor VR-1 Sparrow (5 kW thermal). It is mainly used for training purposes.

In the Karlín tunnel in Prague, the ÚJF runs a microtron MT25[3] with a peak energy of 25 MeV and peak power consumption of 3 MW.

There are several uranium mines and/or exploration sites in the Czech Republic, all of which are either decommissioned or under decommissioning (Figure 1):

- 3 mines under decommissioning at the Liberecký region, district Česká Lípa
- 1 mine under decommissioning in Central Bohemia, Příbram district
- 1 mine under decommissioning and 1 decommissioned mine at the Vysočina Region, Žďár nad Sázavou District
- 2 decommissioned mines at the Plzeňský Region, Tachov District
- 1 decommissioned mine at the Plzeň Region, Tachov District
- 1 mine under decommissioning at the Karlovarský Region, Sokolov District
- 1 decommissioned mine at the Jihočeský region, Jindřichův Hradec district
- 1 decommissioned mine at the Pardubický region, Chrudim district
- 2 decommissioned explorations at the Vysočina region

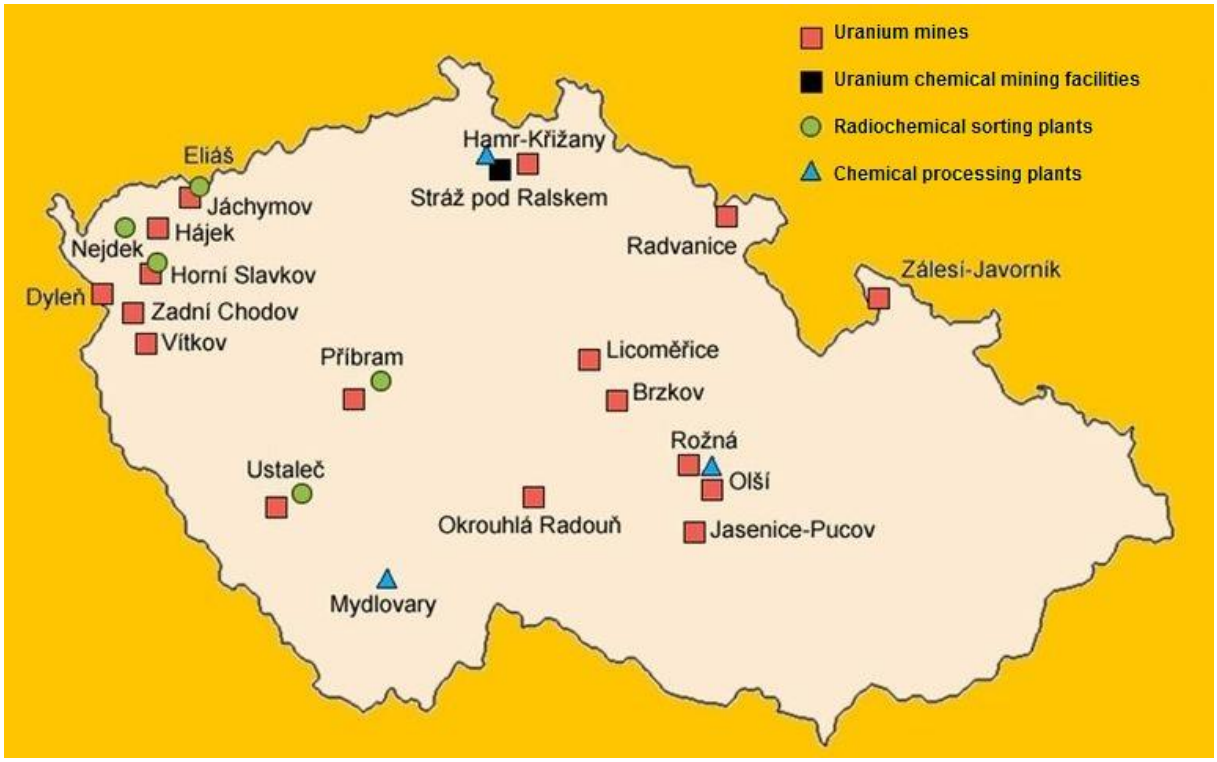

Figure 1. Uranium mining facilities in the Czech Republic

Finally, the following facilities in the Czech Republic should be also mentioned:

- A uranium processing plant under decommissioning (South Bohemian Region, district České Budějovice)
- Two decommissioned (Karlovarský Region, Karlovy Vary District) and seven under decommissioning (around the Bohemia territory) uranium tailing ponds
- A quarry dump (from a uranium mine, also chemicals) under decommissioning (Karlovarský Region, Karlovy Vary District)

[3] https://www.ujf.cas.cz/en/departments/department-of-accelerators/index.html
https://www.ujf.cas.cz/en/departments/department-of-accelerators/microtron

- Several operating medical facilities using radioactive material for diagnosis (nuclear medicine) or metabolic radiotherapy

Other possible sources of radioactivity in the environment are present in the Czech Republic, such as radioactive waste storage facilities and industries giving raise to naturally occurring radioactive material (NORM) discharges (peat production, metal processing, phosphate industry, titanium oxide pigment production, refractory products and brick manufacture, cement production). Accidental smelting of radioactive sources in steel production has also caused contaminated slag.

Radon prone areas are currently under evaluation. The legislation defines areas with increased risk emanating from radon, namely individual municipalities, and explicitly stipulates obligations for the operators of workplaces on the underground or first floor of a building located in the areas of these municipalities. In these areas, the probability of exceeding the reference level set for radon is higher than 30 %. Municipalities are listed in a decree. Information on the Radon programme implemented in the country can be found on the National Radiation Protection Institute (SÚRO) website.

No areas contaminated with artificial radionuclides as a result of radiation emergencies or past practices, nor areas contaminated with natural radionuclides from NORM industries, have been reported.

The Czech Republic conducts routine monitoring of radioactivity in the environment, foodstuffs and drinking water, as well as a source related monitoring of radioactivity. These monitoring programmes are also available during emergency situations. The sampling and analysis strategy can be adjusted according to emergency monitoring needs.

3.2 NATIONAL LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING

3.2.1 Legislative acts regulating environmental radioactivity monitoring

The list below presents the legislative acts regulating environmental radioactivity monitoring.

- Atomic Act No. 263/2016 Coll.[4], § 149, §150
- Decree No. 360/2016 Coll. on radiation situation monitoring
- Decree 359/2016 Coll. on Details to Ensure Radiation Emergency Management

3.2.2 Legislative acts regulating radiological surveillance of foodstuffs

The list below presents the legislative acts regulating the radiological surveillance of foodstuffs.

- Act No. 263/2016 Coll., Atomic Act § 149, §150

3.2.3 Legislative acts establishing responsibilities of the various actors

The list below presents the legislative acts establishing the responsibilities of the various actors in environmental radioactivity monitoring.

- Act No. 263/2016 Coll., Atomic Act § 149, §150, § 216 - § 218 and § 220 - § 223
- Decree No. 360/2016 Coll.[4] on radiation situation monitoring
- National Monitoring Programme[5]

[4] https://www.sujb.cz/en/legal-framework/nuclear-law

[5] https://www.sujb.cz/en/radiation-situation-monitoring

3.3 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below includes main international legislative and guidance documents issued by the European Union (EU) and the International Atomic Energy Agency (IAEA). They form the basis for environmental radioactivity monitoring, radiological surveillance of foodstuffs and surveillance of radioactive discharges.

Euratom and 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
- 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

International 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
- *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) 2008, Report to the General Assembly, Vol. I, United Nations, New York, 2011
- *Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda*, 2022, World Health Organisation (WHO)

4 BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1 STATE OFFICE FOR NUCLEAR SAFETY

The State Office for Nuclear Safety[6] (SÚJB) is the central authority of state administration responsible for regulatory activities in the peaceful utilisation of nuclear energy and ionizing radiation, and in the field of non-proliferation of weapons of mass destruction. It is headed by a chairperson appointed by the Government of the Czech Republic. The Office has an autonomous budget and reports directly to the Government of the Czech Republic.

SÚJB carries out the competence of the state. The following activities fall within its scope:

- Exercise of state administration and surveillance in the field of nuclear security, radiation protection, monitoring of the radiation situation, radiation extraordinary event management, security, and non-proliferation of nuclear weapons
- Authorization of activities performed in accordance with the Atomic Act, *e.g.*, siting and operation of nuclear facilities and workplaces with very significant sources of ionizing radiation, ionizing radiation sources and radioactive waste management, radioactive material and radioactive sources transportation
- Approval of documentation relating to ensuring nuclear safety, radiation protection, monitoring of the radiation situation, radiation extraordinary event management, security and non-proliferation of nuclear weapons, limits and conditions of nuclear facilities operation, emergency regulations for nuclear materials and selected radioactive sources transportation, on-site emergency plans of nuclear facilities and workplaces with sources of ionizing radiation
- Laying down the conditions and requirements for radiation protection of residents and workers with ionizing radiation sources (*e.g.*, determination of radiation limits, delimitation of controlled zones), determination of emergency planning zone and requirements for radiation extraordinary event management by permit holders according to the Atomic Act
- Monitoring, assessment, and control of personal exposure including exposure to radon and other natural sources of ionizing radiation
- Control of activities of the radiation monitoring network (RMN) on the territory of the Czech Republic and ensuring the international exchange of data on the radiation situation
- Managing the state system of registration and control of nuclear materials, state systems of registration of license holders, import and export of selected items, ionizing radiation sources, registration of occupational and population exposure
- Ensuring cooperation with the International Atomic Energy Agency
- Provision of information in the field of radioactive waste management and reporting on its activities to the public and to the Government of the Czech Republic
- Provision of data on measurement and assessment of the effects of radioactive materials, chemicals and biological substances on humans and the environment, including the assessment of the level of protection of individual and collective protection equipment against these materials
- Coordinating and managing activities in guaranteeing obligations resulting from the Chemical Weapons Convention (CWC) and the Biological Weapons Convention (BWC). The Office carries out the function of state surveillance over the measures related to the prohibition of chemical

[6] https://www.sujb.cz/en/

weapons in accordance with the Act No. 19/1997 Coll. and over the measures related to the prohibition of biological weapons in accordance with the Act No. 281/2002 Coll. (Biological Act)

- Exercising the competence of national authority under the Comprehensive Nuclear-Test-Ban Treaty, the Bacteriological (Biological) and Toxin Weapons Convention and the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction

4.2 National Radiation Protection Institute

The National Radiation Protection Institute[7] (SÚRO) is a public research institution established by the decision of the chairman of the State Office for Nuclear Safety (SÚJB) on October 20, 2010, which became effective on January 1, 2011. SÚRO performs research and provides technical support in areas of radiation protection and nuclear safety in order to protect people and the environment against harmful effects of ionizing radiation utilizing special expertise, competency and technical capabilities, including special designed laboratories and advanced measurement methods and techniques. SÚRO conducts research projects and provides public services focused on public, medical and occupational exposures to man-made and natural sources of ionizing radiation.

4.3 State Veterinary Institute Prague

The State Veterinary Institute Prague[8] (SVÚ Prague) is an organisation co-funded and controlled by the state. It was established by the Ministry of Agriculture of the Czech Republic for the purpose of providing veterinary laboratory diagnosis. The Institute is part of the organisational structure of the State Veterinary Administration.

The Institute's primary activities are the following:

- Laboratory diagnosis of infectious and other animal diseases and causes of animal deaths
- Laboratory and sensory testing of samples of biological materials, raw materials, foods and feedstuffs, water, environment, medicinal products, hygiene disposables and, where necessary, other samples in order to assess their health safety and quality (testing includes radioactivity measurements)
- Laboratory checks in animal breeding
- Detecting undesirable residues in the human food chain and in the environment (including radioactivity)
- Pursuit of the activity of accredited testing laboratories and accredited certification bodies for products within the scope of the applicable accreditation
- Sampling for laboratory and sensory analysis
- Pursuit of the activities of national reference laboratories and reference laboratories
- Consultancy, education and training in agriculture and food industries within the Institute's scope of the activities

[7] https://www.suro.cz/en

[8] https://www.svupraha.cz/en

4.4 T.G. MASARYK WATER RESEARCH INSTITUTE

The T. G. Masaryk Water Research Institute[9] (VÚV TGM), a public research institution, was established as one of the first scientific institutes in the independent republic of Czechs and Slovaks. The Institute operates under the auspices of the Ministry of the Environment and since 1993 has begun to act as one of its contributory organisations. As a public research institution, the Institute was established by the Ministry of the Environment on 12 December 2006.

The objective of VÚV TGM is to conduct research on the status, use, and changes of aquatic ecosystems and their linkages in landscape and related environmental risks, waste and packaging waste management, as well as to provide professional support for water protection, flood prevention, and management of waste and packaging waste, based on the above-mentioned research. As a part of its routine monitoring programme, the Institute carries out monitoring of radioactivity (^{3}H, ^{90}Sr, and ^{137}Cs measurements) in surface waters and drinking water.

[9] https://www.vuv.cz/en

5 RADIOACTIVITY MONITORING IN THE CZECH REPUBLIC

5.1 GENERAL

The radiological situation on the Czech Republic territory is monitored by the Radiation Monitoring Network (RMN), which is coordinated by the State Office for Nuclear Safety (SÚJB). In addition to SÚJB, its Regional Centres (RC), the National Radiation Protection Institute (SÚRO) and the holders of license for operation of nuclear installations supply data to the RMN. Details of RMN purpose and organization are regulated by Decree No. 360/2016 Coll. on Radiation Situation Monitoring. Further requirements on radiation situation monitoring are laid down in Decree 359/2016 Coll. on Details to Ensure Radiation Emergency Management, and in the authorized monitoring programmes.

The Czech Republic carries out a comprehensive environmental monitoring program, which is summarized in the Table I below and described in the following paragraphs. The network is divided into the network for external exposure, the network for external and internal exposure, and the network for internal exposure.

The national environmental monitoring program covers the national territory and the Prague capital region extensively. Ambient gamma dose rate in Prague is monitored in real time at four stations. Airborne radioactivity is monitored at two locations and fallout at one location. Environmental monitoring activities based on periodic samples collected from the capital region include mixed diet (both individual ingredients and complete meals) and household water.

Monitoring activities are carried out by SÚRO; most of the samples are analysed in the SÚRO laboratories; some of the water-related samples are analysed in the T. G. Masaryk Water Research Institute. Samplings related to animal production are carried out by the State Veterinary Institute.

Table I. Main radionuclides monitored within the off-line program in the Czech Republic (routine)

Off-line monitored media	Main radionuclides monitored	Measurement frequency
Ambient gamma dose rate	Beta/gamma, gamma dose rate	Monthly
Ambient integrated gamma dose	Cumulated gamma dose (reading TLD exposed during 3 months at 52 sites)	Quarterly
Aerosols	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb, ^{131}I, ^{90}Sr, β-emitters, ^{238}Pu, ^{239,240}Pu	Weekly and monthly in the Czech Republic territory ^{90}Sr, ^{238}Pu, ^{239,240}Pu – quarterly in Prague
Radon	Rn	Monthly
Rain (precipitation)	^{3}H	Monthly, quarterly in Plástovice and Zálužice
Dry atmospheric deposition	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb, β-emitters	Monthly, quarterly β-emitters in Plástovice and Zálužice
Gaseous forms	Iodine + ^{3}H, ^{14}C	Monthly, iodine is only measured if it is present in aerosol form.
Groundwater	^{137}Cs and ^{3}H on NPPs sites, Unat and Ra-226 around U mining sites	Yearly
Surface water	^{137}Cs, ^{3}H, ^{90}Sr, Unat and ^{226}Ra around U mining sites, α-emitters, β-emitters	Monthly/Quarterly to Yearly
Drinking water	^{3}H, ^{90}Sr, ^{137}Cs	Quarterly/Yearly
Water supply sludge	^{137}Cs	Yearly
Sediment	^{137}Cs	Yearly
Uncultivated soil	^{137}Cs, ^{40}K, nat. radionuclides	Yearly
Leafy vegetables	^{137}Cs	Yearly
Other vegetables and fruits, cultivated	^{137}Cs	Yearly/twice per year

Off-line monitored media	Main radionuclides monitored	Measurement frequency
Grain	^{137}Cs	Yearly
Bioindicators, mushrooms, berries	^{137}Cs	Mushrooms: 40 samples per year Berries: 25 samples per year Bioindicators: Yearly
Milk	^{137}Cs, ^{90}Sr in cow milk (^{40}K in sparse network)	Quarterly, around NPPs 50 samples per year from the non-permanent sites Twice per year
Meat	^{137}Cs	Quarterly
Fish	^{137}Cs	20 samples/year
Mixed diet	^{137}Cs, ^{90}Sr	Once/twice per year, 20 samples/ year

5.2 RADIATION DOSE AND DOSE RATE

5.2.1 Integral dose network

Integral radiation dose is monitored using a network of TLD detectors (Figure 2). The organizations in charge of operating the system(s) are the State Office for Nuclear Safety (SÚJB), the Czech Hydrometeorological Institute (ČHMU) and the National Radiation Protection Institute (SÚRO).

The TLD is a card containing 4 thermoluminescent detectors inserted in a cover with incorporated different filters. The thermoluminescent material used is LiF:Mg,Cu,P. The dosimeters are measured by means of an automatic TLD Harshaw 6600 reader. In a normal radiation situation, the measurements are performed quarterly.

Figure 2. Integral dose monitoring network in Prague

5.2.2 Early warning network

The Czech Republic runs an on-line continuous environmental monitoring program for radioactivity in air. The Early Warning Network (EWN) is formed by 169 sites, where measurement of integrated ambient dose rate is performed. It consists of 71 measurement stations distributed over the entire country, supplemented by 98 measurement stations around the NPPs (47 around Temelín and 51 around Dukovany). In Prague there are four monitoring stations (Figure 3).

The 71 national network measurement stations use GM detectors operated with a time resolution of 10 minutes both in routine and emergency situations. Dose rates up to 1 Sv/h can be measured. No radionuclide identification capabilities are available in this network, hence no direct measurement of the radionuclide concentration in air, nor radionuclide specific dose rates are being measured. Probe type for dose rate measurement is NuDET EGM-02 by the Nuvia company (Measuring range H*(10): 50 nSv/h to 2 Sv/h, 10 min. mean value, energy range: 40 keV to 3 MeV).

The 98 measurement stations around the NPPs use ionization chambers or proportional counters and are operated with a time resolution of 10 minutes in routine situations. No radionuclide identification capabilities are present in this network, hence no direct measurements of the radionuclide concentration in air, nor radionuclide specific dose rates are measured.

The on-line monitoring system is operated by SÚJB through its Regional Centers (RC) and the National Radiation Protection Institute (SÚRO). It receives data from all automatic stations as well as from all monitoring laboratories. Data are sent to the MonRaS database (Monitoring of Radiation Situation[10]) and EURDEP every 10 minutes (in the case of average dose rate), or immediately after obtaining the measurement results (for laboratory measurements).

Figure 3. Early Warning Network in Prague

5.3 ENVIRONMENTAL SAMPLING

5.3.1 Air

Air is monitored through continuous sampling of aerosols and gaseous iodine followed by periodic measurements. The following samplers are used:

- JL-900 Snow White from the company Senya Finland. JL-900 Snow White is a high-volume air sampler with a standard flow rate of 900 m³/h produced for continuous outdoor use. It is used for monitoring both particulate and gaseous (Iodine) radioactivity in air. Filter is changed once a week; iodine cartridge replacement period is one month.
- JL-150 Hunter from the company Senya Finland (back up). JL-150 Hunter is a versatile medium range air sampler with a standard flow rate of 150 m³/h.

In Prague there are two Snow White samplers located at the SÚRO premises (Figure 4, Table II).

[10] www.sujb.cz/en/radiation-situation-monitoring

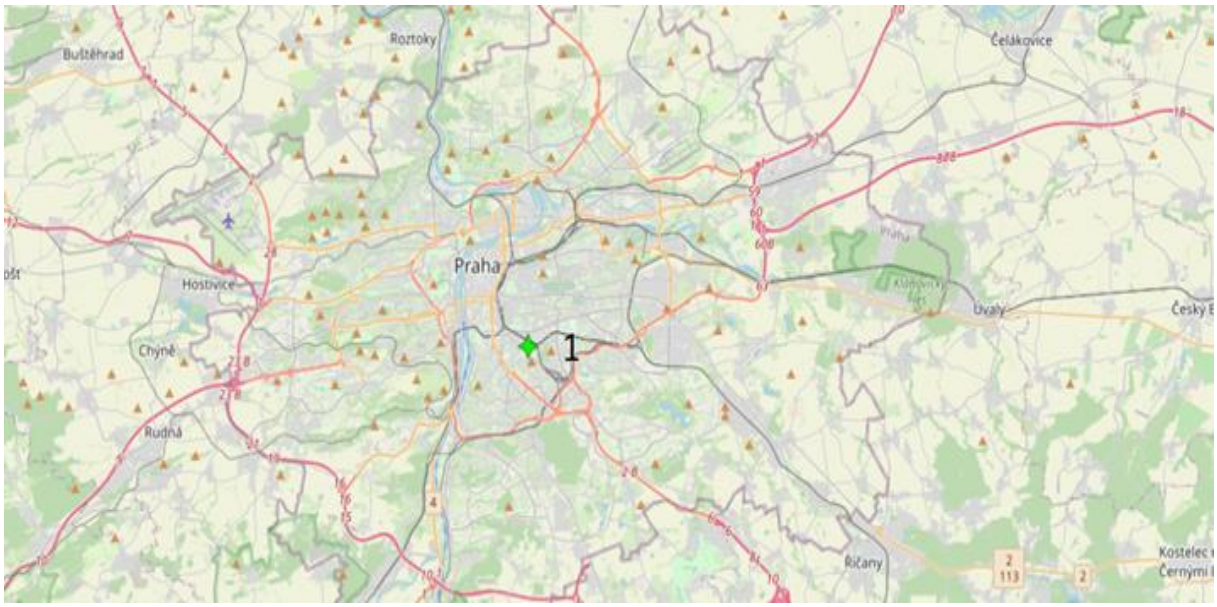

Figure 4. Air samplers collecting particulate matter and gaseous iodine in Prague

Table II. Air sampling data

	Sample	Sampling locations	Frequency of sampling
1	Aerosols, gaseous forms: tritium, carbon, iodine	Prague – Bartoškova	Weekly, Monthly

Sample	Physical quantity	Units	Radionuclides	Name of the methodology
Aerosols	Volumetric activity	Bq/m^3	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb, ^{131}I	VDI – G
	Volumetric activity	Bq/m^3	^{90}Sr, ^{238}Pu, ^{239,240}Pu	VDI – Sr, VDI – TRU
	Volumetric activity	Bq/m^3	Beta emitting radionuclides	VDI – 130
Gaseous forms	Volumetric activity	Bq/m^3	^{3}H	VDI – H
	Volumetric activity	Bq/m^3	^{131}I	VDI – G
	Volumetric activity	Bq/m^3	^{14}C	VDI – C

5.3.2 Atmospheric deposition

Atmospheric deposition samples (rain and dust) are collected at the SÚRO premises (Figure 5) using a Pirkko 800 Fallout Sampler. This is an automatic stainless steel enclosed device meant for collecting rainwater and dry air particles into their separate containers, which are automatically covered by a motorized steel lid as weather changes. For cold environments the system can be equipped with additional heating.

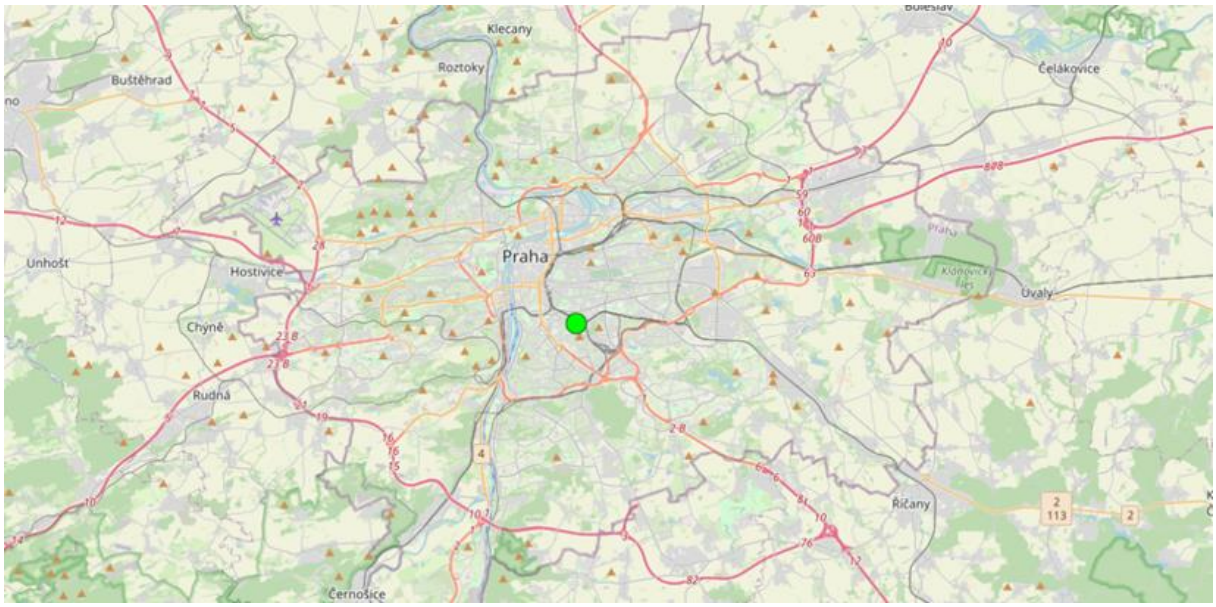

Figure 5. Location of atmospheric deposition collector in Prague

Table III. Atmospheric deposition sampling data

	Sample	Sampling locations	frequency of sampling
1	Dry/wet deposition	Prague – Bartoškova	once a month

Sample	Physical quantity	Units	Name of the sampling methodology	Radionuclides
Dry/wet deposition	Surface activity	Bq/m^2	VDI – G, VDI – H	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb, ^{3}H
			ČSN 75 7612 (BETA)	beta-emitting radionuclides

5.3.3 Surface water

Surface water sampling is carried out by the T. G. Masaryk Water Management Research Institute in cooperation with the state enterprises Povodí (River Board). The samples are analysed in the VÚV laboratory. There are three sample collection points in Prague (Figure 6).

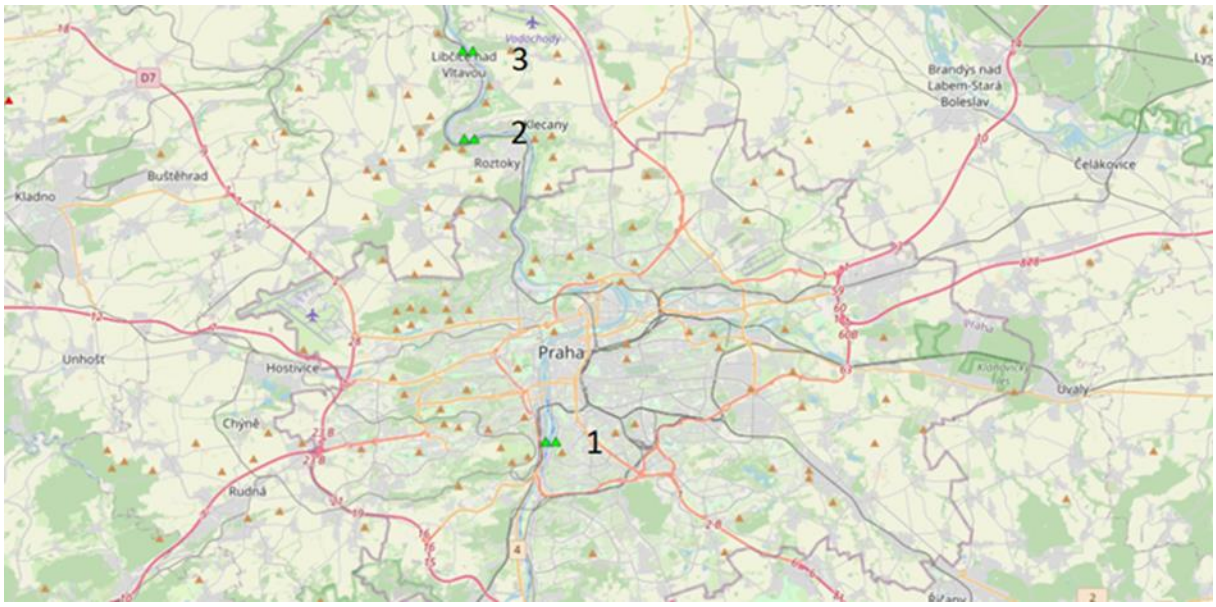

Figure 6. Surface water sampling locations in Prague

Table IV. Surface water sampling data

	Sample	Sampling locations	Frequency of sampling
1	Surface water/ water streams	Vltava – Prague - Podolí	Weekly
2	Surface water/ water streams	Vltava - Husovice	Quarterly
3	Surface water/ water streams	Vltava - Máslovice	Quarterly

Sample	Physical quantity	Units	Name of the sampling methodology	Radionuclides
Surface water	Volume activity	Bq/l	VDI – G, SOP RA6	^{137}Cs
			VDI – Sr, SOP RA9	^{90}Sr
			VDI – H, SOP RA7	^{3}H
			ČSN 75 7611 (ALFA)	alpha-emitting radionuclides
			ČSN 75 7612 (BETA)	beta-emitting radionuclides

5.3.4 Ground water and drinking water

Drinking water sampling is carried out by the T. G. Masaryk Water Management Research Institute in cooperation with the state enterprise Povodí (River Board). The samples are analysed in the VÚV laboratory. There are two collection points in Prague (Figure 7).

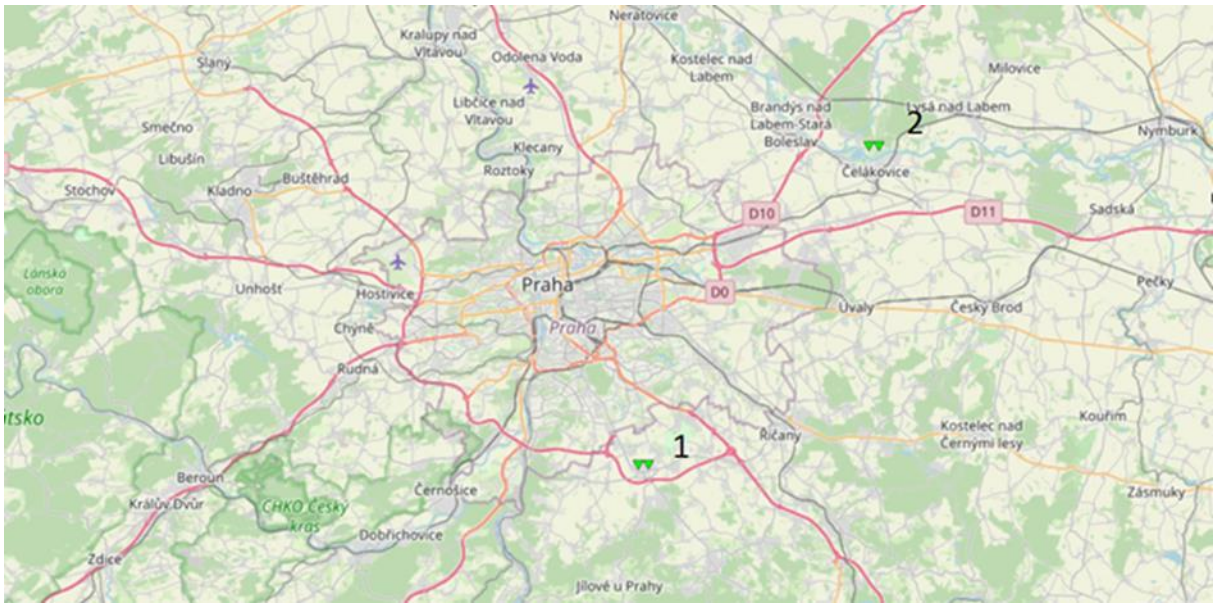

Figure 7. Ground water and drinking water sampling locations in Prague

Table V. Ground water and drinking water sampling data

	Sample	Sampling locations	Frequency of sampling
1	Drinking water / waterworks	Želivka – Jesenice	Quarterly
2	Drinking water / waterworks	Jizerka- Káraný	Quarterly

Sample	Physical quantity	Units	Name of the sampling methodology	Radionuclides
Drinking water	Volume activity	Bq/l	VDI – G, SOP RA6	^{137}Cs
			VDI – Sr, SOP RA9	^{90}Sr
			VDI – H, SOP RA7	^{3}H
Ground supply water	Volume activity	Bq/l	VDI – G	^{137}Cs
			VDI – H	^{3}H

5.3.5 Soil

Soil sampling site for the year 2022 is marked on the map below (Figure 8). Permanent sampling sites are defined only in the emergency planning zones of the nuclear power plants Temelín and Dukovany. On-site soil monitoring (in-situ gamma spectroscopy and sampling) and its evaluation is part of the annual training of the mobile groups.

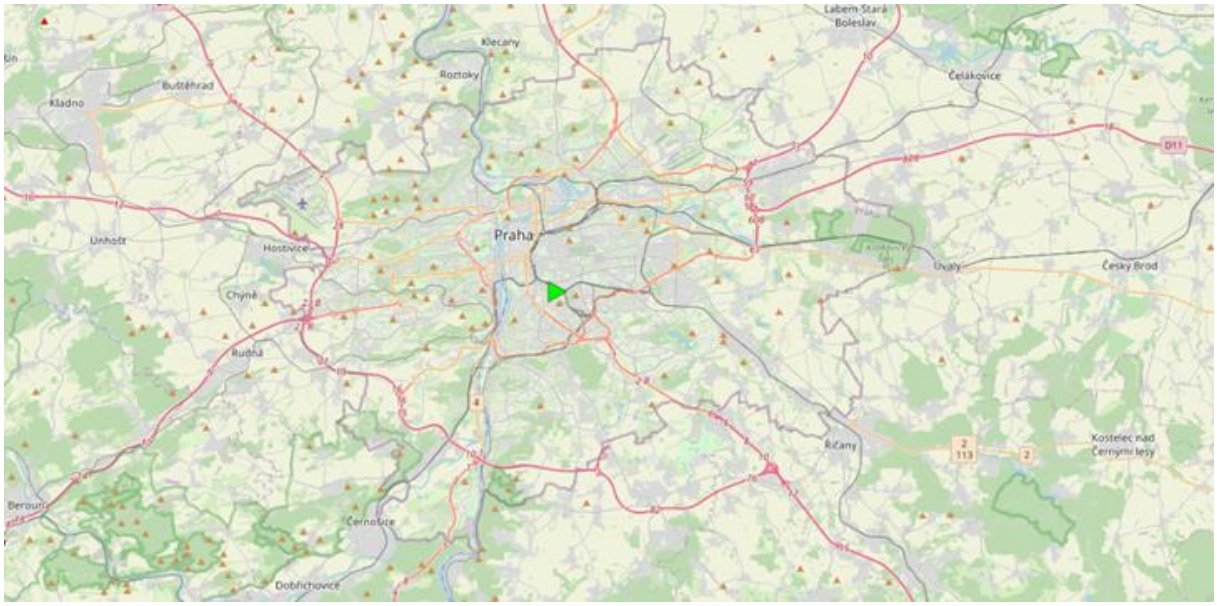

Figure 8. Soil sampling location (2022) in Prague

Table VI. Soil sampling data

	Sample	Sampling locations	Frequency of sampling
1	Soil – spectrometry in situ	SÚRO	once per year

Sample	Physical quantity	Units	Radionuclides
herbage and snow	surface activity	Bq/m^2	^{137}Cs
soils and herbage	mass activity	Bq/kg	^{40}K and natural radionuclides
	surface activity	Bq/m^2	^{137}Cs
soils in situ	mass activity	Bq/kg	^{40}K and natural radionuclides
	surface activity	Bq/m^2	^{137}Cs

5.3.6 Terrestrial and aquatic biota and flora

No fixed sampling points are established for terrestrial and aquatic biota and flora. These items are sampled only on request from the SÚJB.

Table VII. Terrestrial and aquatic biota and flora sampling data

Sample	Physical quantity	Units	radionuclides
Wood	Mass activity	Bq/kg	^{137}Cs
Needles	Mass activity	Bq/kg	^{137}Cs
Leaves	Mass activity	Bq/kg	^{137}Cs
Lichens	Mass activity	Bq/kg	^{137}Cs
Moss	Mass activity	Bq/kg	^{137}Cs
Grass	Mass activity	Bq/kg	^{137}Cs
Algae	Mass activity	Bq/kg	^{137}Cs

5.4 FOOD SAMPLING

5.4.1 Milk

Sampling of milk is conducted twice a year at milk processing plants in Prague and the Central Bohemia Region (Table VIII).

Table VIII. Milk sampling data

Monitored sample	Sampling locations	longitude [°]	latitude [°]	The operator of the sampling point	Frequency of sampling
Cow's milk - consumers	Prague and Central Bohemia Region	14,440933	50,063969	SÚRO	twice a year
Cow's milk - powdered	Prague and Central Bohemia Region	14,461200	50,047533	SÚRO	twice a year

Sample	Physical quantity	Units	Radionuclides
Cow's milk - consumers	Volume (mass) activity	Bq/l (Bq/kg)	^{137}Cs, ^{90}Sr
Cow's milk - raw	Volume (mass) activity	Bq/l (Bq/kg)	^{137}Cs, ^{90}Sr
Cow's milk - powdered	Mass activity	Bq/kg	^{137}Cs, ^{90}Sr

5.4.2 Mixed diet

Mixed diet is sampled for assessing ^{137}Cs and ^{90}Sr in the average daily diet (table in Annex 2). The procedure for measuring the sample is according to the internal regulation VDI-Sr.

5.4.3 Foodstuffs

Foodstuffs (poultry meat, pork, beef, potatoes, apple, flour, oat flakes, onion, carrot, tomatoes, cabbage, barley, corn, oat, wheat, triticale, and rye) are collected for assessing ^{137}Cs (table in Annex 2).

5.4.4 Feeding stuffs

Feeding stuffs (feed – forage, feed – silage & haylage, feed – other and feeding mixture) are collected for assessing ^{137}Cs (table in Annex 4).

5.5 DATA HANDLING

Data providers (ÚJV Řež, ČEZ, SVÚ, VÚV, DIAMO laboratories, mobile groups) upload foodstuff and environmental monitoring data using a Web Presentation Server (WPS). All data except of mobile groups are uploaded in IRIX data format.

The SYNC application imports data from WPS, early warning network (EWN) and hydrometeorological data (checking duplication, comparing monitoring levels, generating warning messages, *etc.*). SYNC exports Early Warning Network data to Austria, Slovakia and EURDEP every hour. Application allows data export to the REM database and selected data to IRIX or EURDEP format.

All laboratory and EWN data are stored in the MonRaS database. Figure 9 illustrates the data flow.

Contact point SÚRO checks the radiation situation daily. Warning SMS-messages and emails are used for alerting. SÚJB administrators check the system in the evening and twice a day on non-working days. In case of an EWS problem, SÚJB administrators activate the service company NUVIA.

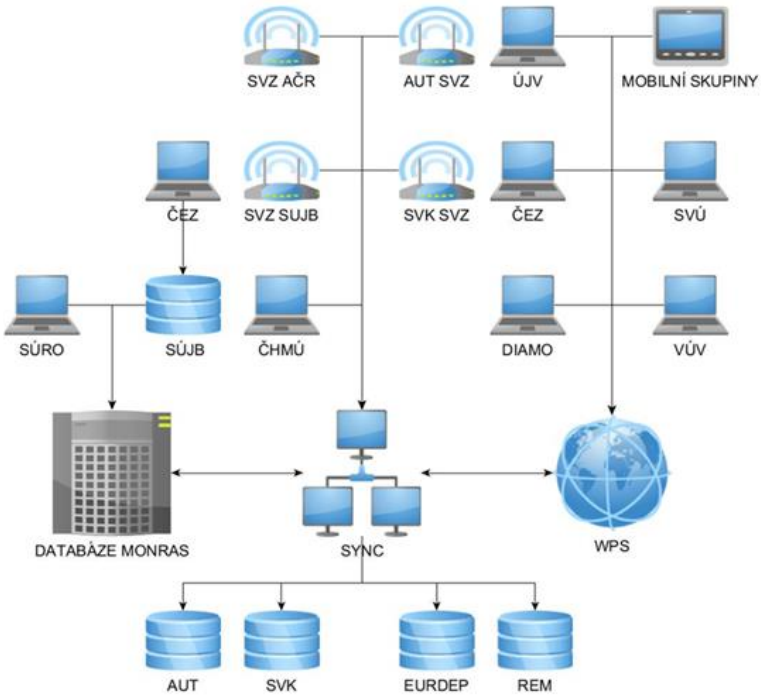

Figure 9. MonRaS data transmission

5.6 EMERGENCY MONITORING

Monitoring of radioactivity in the environment in the event of an emergency is carried out by SÚJB, SÚRO, the armed forces and professional fire brigades. There are 25 mobile groups for terrestrial monitoring in the Czech Republic, belonging to SÚJB RC, SÚRO, Customs Offices, Police, Fire Rescue Service, Armed Forces, Dukovany and Temelín NPP. During an emergency, mobile groups are deployed by the SÚJB Crisis Staff. Collection of gamma radiation spectra and monitoring of aerosols and iodine in the atmosphere can be performed using portable devices. In a normal situation, the mobile groups exercise once a month. The groups use a portable device to record the gamma dose rate along the route. 10-second average values are transmitted to the Data Centre together with the coordinates of the measurement point, date and time of measurement at the selected time intervals.

There are two mobile groups for airborne monitoring in the Czech Republic, one within the SÚRO using a Police helicopter and one at the Armed Forces. During an emergency, the main task of the air groups is to perform rapid mapping of the radiation situation. In a normal situation, the air groups exercise twice a year. The air groups measure the gamma dose rate and activities of selected artificial radionuclides (mainly ^{137}Cs, potentially also ^{131}I) during the flight using portable devices. The map with the measured values of dose rate is transmitted to the Data Centre.

Gaseous iodine is monitored in the Czech Republic regularly using air sampling stationary stations. Determination of volume activity of ^{131}I in iodine cartridges is performed by gamma spectrometry measurements.

In the area of Prague and its surroundings, mobile groups of the SÚRO and the Fire Rescue Service are on 24/7 emergency duty. SÚJB mobile group is available in 2 hours.

Capabilities and instrumentation of the individual units is the following:

- SÚJB Mobile group is equipped with handheld devices (dose rate meters FH-40, RadEye B20-ER DC-3E, NaI Gamma spectrometer RT-30, surface contamination meter LB SCIN 124, mobile air sampler (Brno, Ceske Budejovice, SÚRO)), MobDOSE (carborne monitoring device) + SPDose application for data transmission (a new device called MobRAMS with GSM and satellite data transmission is under development).
- SÚRO mobile group has a dedicated car equipped with a HPGe detector and a NaI detector for field measurements and a ground unmanned vehicle for remote monitoring.
- SÚRO airborne mobile group together with the Army CR/Police CR helicopter can carry out airborne monitoring. A radiation monitoring drone is also available.
- SÚJCHBO mobile group can carry out radiation monitoring by using a drone (Kamenna). SÚJCHBO uses the MORD application, which can transmit real-time data from the drone to a web server. It also has special equipment for outdoor contamination monitoring and nuclide identification.
- Fire brigades are equipped with handheld dose rate monitors and nuclide identification devices. In addition, they operate five mobile laboratories equipped with dose rate monitors, nuclide identification devices, contamination monitors, gamma spectrometers and neutron detectors.
- SÚRO has 10 mobile early warning stations (MOSTAR) (Figure 10). These are self-powered standalone dose rate monitoring stations for placement anywhere in the Czech Republic. These stations feature a photovoltaic panel and can communicate using GSM network.

The Czech Republic has signed agreements with all its neighbouring states concerning the exchange of information (Germany, Poland, Slovakia, and Austria), issues of common interest in the field of nuclear safety and radiation protection (Germany) and cooperation with the Nuclear Regulatory Authority (Slovakia). Mostly these agreements focus on the exchange of information.

Austria has one AMS-02 HPGe station near the Temelín NPP based on bilateral agreements. The Czech Republic has no radiological monitoring stations installed abroad. Border monitoring is conducted only in emergency exposure situations. Dose rate and surface contamination measurements are intended for rapid sorting of persons, vehicles and objects leaving the enclosed area affected by a radiation emergency. The measurements of surface contamination of persons are carried out as a rapid indicative measurement to determine the need for decontamination and afterwards, the effectiveness of the decontamination. The sites for measurement and decontamination are established in the off-site emergency response plans for the emergency planning zones or are established in cooperation with the Ministry of Interior – General Directorate of Fire Rescue Service and the SÚJB, depending on the affected area and the evolution of the emergency exposure situation. In a normal situation, measurements of dose rate and surface contamination are carried out during annual drills for emergency exposure situations, using portable devices (or mobile portal detectors).

Figure 10. MOSTAR standalone dose rate monitoring station

5.7 INFORMATION FOR THE PUBLIC

The public in the Czech Republic is informed about environmental radioactivity in both normal and emergency situations. There is information transmitted on-line, in real time, as well in the form of periodic reports (also posted on-line on the nuclear regulatory body website[11]). Data from the online monitoring is published in real-time by the nuclear regulator through a dedicated website. Results of the off-line programme, together with interpretation and conclusions, are also made available to the public by periodic reports by the regulator.

Besides the communications by the nuclear regulatory authority mentioned above, the nuclear operators also have responsibilities to communicate with the public both during routine and emergency situations.

[11] https://www.sujb.cz/en/reports

In the event of an emergency, communication with the public is the responsibility of the government, the nuclear site operators and the nuclear regulatory body.

Table IX below shows the data provided to the public as part of the MonRaS[12] web application. Data is updated daily in the application (except of the Early Warning Network data). Data are available in the form of graphs and tables. Each monitoring item if followed by additional information (device, sampling, *etc.*). Early warning network data are updated every hour. Dose rate hour data persist for 2 days. Older data are represented by 1 value for 1 day.

Data available to public are automatically checked according to pre-set levels during normal monitoring. Values higher than those levels are not uploaded to MonRaS application. All values are uploaded to web MonRaS application during emergency monitoring (including values higher than pre-set levels). The published data includes measurements taken as part of a nuclear accident preparedness training. These data are presented in a separate collection.

Complete information about country radiation monitoring is published in the SÚJB annual reports. Radiation monitoring data are provided to the Ministry of Environment for inclusion into the Czech Environmental Information Agency (CENIA) system.

Table IX. Public monitoring data

		Availability time
Network for external exposure	Early Warning Network	30 days
	Network of integral measurement (TLD)	5 years
	Car-Borne monitoring	30 days
	Air-Borne monitoring	2 years
Environmental sampling	Aerosols	2 years
	Fallout	
	Surface water	
	Drinking water	
	Milk	
	Meat	
	Venison	
	Fish	
	Potatoes	
	Wild berries	
	Mushrooms	
	Feeds	
	Grains	
	Fruit	
	Vegetables	

[12] https://www.sujb.cz/aplikace/monras

6 LABORATORIES PARTICIPATING IN ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES IN PRAGUE

6.1 NATIONAL RADIATION PROTECTION INSTITUTE

The National Radiation Protection Institute has an advanced and well-equipped radiological laboratory for analyzing environmental samples. Selected SÚRO methods, as well as the quality management system for three laboratories forming an entity “Testing laboratories of SÚRO", are accredited according to ČSN EN ISO/IEC 17025 standard. Annex 2 provides an overview of the laboratory analytical program.

Sample reception takes place in a dedicated room (check of sample cover, consistency, and documentation). The SÚRO mobile group uses QR codes (contains information about sample and sampling procedure) to mark the sample instead of paper documentation.

There are no permanent soil sampling points designated in the territorial network; it is the duty of mobile groups (SÚJB and SÚRO) to carry out soil sampling and in-situ measurements once a year (*e.g.*, during drills or emergency exercises). Soil samples are handed over to the SÚRO laboratory, which carries out the measurements and uploads the data into MonRaS database.

Sample preparation is described in controlled documented methodologies for the determination of radionuclides. Concentration methods (drying, evaporation, combustion, grinding, pressing, gas compression) and separation methods (distillation, ion exchange, co-precipitation, extraction...) are used for sample preparation, as follows:

- Radionuclides detectable by gamma spectrometry - concentration methods
- Transuranic isotopes (^{241}Am, ^{238}Pu, ^{239,240}Pu, ^{242}Cm, ^{243,244}Cm) - combustion, acid leaching, co-precipitation, ion- and extraction chromatography
- ^{90}Sr – oxalate method - burning, leaching, co-precipitation
- Uranium isotopes - combustion, fusion (melting) or acid leaching, co-precipitation, ion- and extraction chromatography
- ^{3}H - distillation
- ^{14}C - sorption
- ^{226}Ra - combustion, fusion (melting), co-precipitation

In addition to conventional laboratory equipment SÚRO also has a pressing equipment for compacting aerosol filters, powerful mill and mixer, analytical scales, muffle furnaces, dryers, centrifuges and equipment for electrodeposition.

Counting times vary according to the requirements for determination accuracy and detection limits (MDA). Some measurements are repeated in a series (for example, in alternating mode with background measurement or standard measurement). Some measurements last up to a week, in which case *e.g.* a MDA of 0,01 μBq/m^3 can be achieved (aerosol filters) (‘screening’ MDA is reported as 1 μBq/m^3).

Determinations are carried out according to the following documented methodologies and documentation of SÚJB:

- Radionuclides detectable by gamma spectrometry – spectrometric set with HPGe detectors (measurement in different geometries)
- Radionuclides detectable by alpha spectrometry – spectrometric route with PIPS detectors (Uranium isotopes, Transuranic isotopes)

- Determination of ^{90}Sr – low background proportional detector
- Determination of ^{3}H – liquid scintillation counting (LSC)
- Determination of ^{14}C – liquid scintillation counting (LSC)
- Determination of ^{226}Ra – emanometry – Lucas chamber detector

Several methods are also available to SÚRO for measurements in emergency situations.

Measurements are made using calibrated and verified instruments. For calibrations SÚRO uses standards prepared in the Czech Metrology Institute (ČMI) and Monte Carlo methods. ČMI-prepared standards are also used as tracers.

For the analysis of gamma and alpha spectrometry, software Genie and possibly other software, such as Excel, R, Efftran, Mefftran, are used. For analysis of other radionuclides, Excel is mostly used.

The laboratory counting equipment are the following:

- Spectrometric sets with HPGe detectors – 18 detectors (Canberra, ORTEC) in shields from Fe or Pb including 2 HPGe detectors located in a gamma-automatic sample changer and spectra analysis.
- Spectrometric routes with PIPS detectors – 12 detectors (Canberra) in vacuum chambers.
- Low-background proportional computer (^{90}Sr determination) – 1x FHT 770 T6 (with 6 proportional detectors), 1x Protean MPC 9604 (with 4 proportional detectors).
- Lucas chambers, photomultiplier and counter JKA 300 (determination ^{226}Ra)
- Liquid scintillation counting (LSC) (determination of ^{3}H, ^{14}C) – HIDEX 300 SL (autosampler for 40 samples). (Another LSC will be purchased from HIDEX.)

The spectra and results of analyses are stored in defined locations. In particular, the results are recorded in the LabSys laboratory database system. If the best estimate of activity is below lower limit of detection (LLD), the LLD is given as a result. The LLD value is determined according to standard ČSN EN ISO 11929-1 for a 95 % confidence level ($\alpha = \beta = 0.05$).

The results of the analyses are sent from LabSys to the MonRaS database (currently via a conversion bridge with a direct link between LabSys and MonRaS, in the future using files in IRIX format).

Selected samples are archived (*e.g.*, aerosol filters), others are disposed of after verification of the results (food samples).

The SÚRO laboratories carry out an annual internal audit and are subject to regular audits of the Czech Accreditation Institute (ČIA) serving as the National Accreditation Body. SÚRO also regularly participates in many laboratory intercomparisons, for example each year in a comparison organised by the IAEA and in all comparisons organised in cooperation with SÚJB in accordance with Annex 7 to Decree No. 360/2016 Coll.

As regards determination of ^{14}C in mixed diet, research is still in progress by the SÚRO, which is seeking approval of a method for the determination of ^{14}C using human hair samples.

SÚRO publishes their measurement results[13] *e.g.* on indoor ambient dose measurements (TLD) as well as on radiation in environment measurements obtained by mobile means.

[13] https://www.suro.cz/aplikace/ramesis/#/safecast

6.2 T.G. MASARYK WATER RESEARCH INSTITUTE

The T.G. Masaryk Water Research Institute laboratory performs radiological analysis of water and aquatic environment samples. The laboratory is accredited by the ČIA and it has a certificate of the correct operation of the laboratory by ASLAB (Centre for the assessment of laboratories). Annex 3 provides an overview of the laboratory analytical programme. The state overview concerning surface waters' quality is in hands of the Czech Hydrometeorological Institute (ČHMU); the SÚJB is overseeing both surface and drinking water.

Surface water samples are collected by a state enterprise Povodí (River Board) in charge of particular river management (*e.g.*, Povodí Odry), and either delivered to VÚV TGM directly or by postal shipping. The laboratory has a database of samples (LabSys).

Sample preparation involves the following methodologies:

- SOP RA6 - Determination of gamma-emitting radionuclides (drinking water, surface water, sediment, sludge and aquatic biomass)
- SOP RA9 - Determination of ^{90}Sr (drinking water, surface water, sediment, aquatic biomass)
- SOP RA7 - Determination of tritium activity by volume (drinking water, surface water)
- SOP RA2 - Determination of total volumetric beta activity (drinking water, surface water)

The analytical methods used for measuring radioactivity in surface waters (reservoirs and water streams) are the following:

- Determination of total beta activity by volume after subtraction of the ^{40}K contribution

  Sampling in the individual sampling point, always about 2 liters of unfiltered sample, stabilized by acidification and concentrated by evaporation. Sampling, sample pre-treatment and measurements are carried out by the Povodí. Data transfer is carried out by the VÚV.

- Determination of the volume activity of ^{137}Cs

  Sampling in the individual sampling point, always about 20 l of unfiltered sample, stabilized by acidification and concentrated by evaporation. Sampling and evaporation are carried out by the Povodí. Final sample processing, measurement, evaluation and data transfer are carried out by the VÚV.

- Determination of ^{3}H

  Sampling in the individual sampling point, approx. 0,5 l of unfiltered sample, sampling (except for the sampling point Vltava Prague Podolí, where sampling is carried out by VÚV) is carried out by Povodí. Sample processing, measurement, evaluation and data transfer is carried out by VÚV.

- Determination of the volumetric activity of ^{90}Sr

  Evaporated mixed sample from the individual sampling point after determination of ^{137}Cs; final processing and measurement, evaluation, and data transfer by the VÚV.

The analytical methods used for measuring radioactivity in drinking water (water treatment plants) are the following:

- Determination of the volumetric activity of ^{137}Cs

  Sampling in the individual sampling point, always about 20 l of unfiltered sample, stabilized by acidification and concentrated by evaporation. Sampling and evaporation are carried out by the Povodí. Final sample processing, measurement, evaluation and data transfer are carried out by the VÚV.

- Determination of ^{3}H

  Sampling in the individual sampling point, approx. 0,5 l of unfiltered sample, is carried out by Povodí. Sample processing, measurement, evaluation and data transfer is carried out by VÚV.

- Determination of the volumetric activity of ^{90}Sr

  Evaporated sample from the individual sampling point after determination of ^{137}Cs is used. Final sample processing and measurement, evaluation and data transfer are carried out by the VÚV.

The following measurement devices are available in the laboratory:

- 4 gamma spectrometers (GR3018, GR3019, GC4519, GC5019)
- 3 liquid scintillation counters (Quantulus 1220, TRI-CARB 3170 TR/SL, Quantulus GCT 6220)
- 1 EMS3 Proportional detector POB 302E (Empos)

Equipment calibration is based on certified standards by Czech Metrology Institute (ČMI). Device verification is carried out every 2 years by the ČMI. The results are recorded in the samples registration database LabSys and exported in IRIX form to the MonRaS database.

Liquid sample residues are disposed of after radiochemical determination, as are the fish samples after gamma spectrometric analysis. Solid samples (sediments, water sludge) after gamma spectrometric analysis are stored for 6 years.

The laboratory takes part in proficiency tests organized by the IAEA-TEL, IAEA-TERC and JRC-REM, and in national inter-comparison exercises organised by the SÚJB.

6.3 State Veterinary Institute Prague

The State Veterinary Institute Prague laboratory performs radiological analysis of food samples. The laboratory is accredited according to ČSN EN ISO/IEC 17025 standard. Annex 4 provides an overview of the laboratory analytical programme.

Registration of the samples in the laboratory information system is described in the Quality Guide and related documents. The samples are clearly and uniquely identified. Access to sample information is managed and allowed only to authorized workers.

The following counting equipment is available:

- ORTEC GEM 60 HPGe detector, ORTEC DSPEC 50TM analyzer
- ORTEC GEM 50P4-83 HPGe detector, ORTEC DSPEC 50TM analyzer
- Canberra GC5019 HPGe detector, ORTEC DSPEC 50TM analyzer

Calibration of the gamma spectroscopy systems is done using MBSS mix and MBSS 2 calibration standards. Software MAESTRO 32 or GammaVision (ORTEC) are used. The ^{137}Cs peak is checked using the MBSS 2 standard before each sample measurement.

The measurement data and reports of all samples are stored in the central repository. They are backed up daily. All data are stored in the laboratory information system (Labsystem SVÚ). Data are reported to national database MonRaS using the IRIX format.

Samples are stored (archived) for one month after the test results were reported. Above-limit/non-compliant samples are stored for 3 months in a dedicated location, separate from other samples. Storage conditions are monitored.

The laboratory takes part in SÚJB interlaboratory comparison exercises.

7 VERIFICATIONS

7.1 INTRODUCTION

Verifications were carried out in accordance with the agreed programme (Annex 1). This chapter summarises the verifications carried out by the verification team. The team has assessed the monitoring arrangements based on their own expertise and comparison with similar arrangements in other Member States.

The outcome of the verification is expressed as follows:

- A '*Recommendation*' is made when there is a clear need for improvement in implementing Euratom Treaty Art. 35. These are included in the main conclusions of the verification. The Commission requests a report on the implementation of the recommendations – lacking implementation of a recommendation can lead to a reverification.
- A '*Suggestion*' is made when the verification team identifies an action, which would further improve the quality of the monitoring.

In addition, the team may '*commend*' particularly good arrangements, which could serve as a best practice indicator for the other EU Member States.

7.2 MONITORING PROGRAMME

The verification team verified the structure of the environmental radioactivity monitoring programme in the Czech Republic, and Prague in particular, including automatic, mobile, and laboratory-based monitoring described in Chapter 5.

The team notes that the current programme is sufficient to cover all relevant environmental compartments and there are sufficient resources for carrying out monitoring in the event of an emergency.

Results of the monitoring programme are made available to the public on-line (MonRaS system[14]) and in annual reports both in Czech and English. The verification team noted that the MonRaS system can display both automatic and sample-based data, the latter including car-borne and airborne survey data (Figure 11).

> *The verification team commends the clear and versatile MonRaS website for making radioactivity monitoring data available to the public.*

[14] https://www.sujb.cz/aplikace/monras

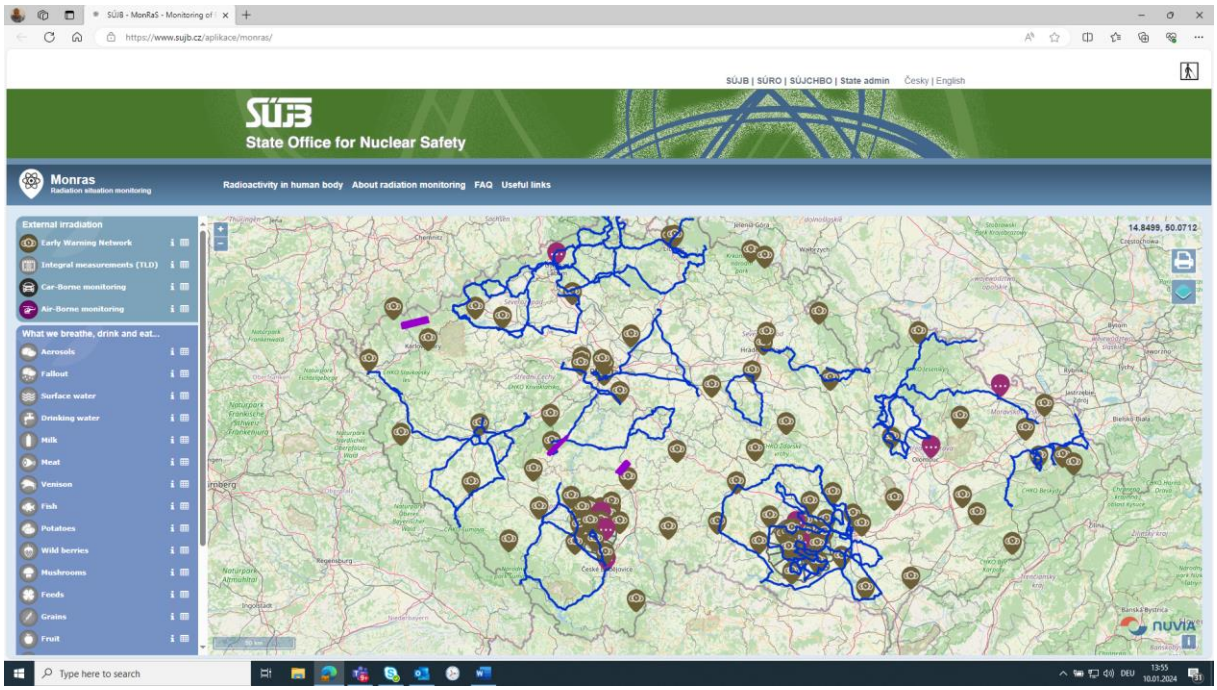

Figure 11. MonRaS website for making radiation monitoring results available to the public

7.3 T.G. Masaryk Water Research Institute

7.3.1 Radiological laboratory

The verification team verified the radiological laboratory of the T.G. Masaryk Water Research Institute[15]. The laboratory carries out analysis of surface water, drinking water, sediments, sludge (from water supply stations), and fish. Besides determining the total alpha and total beta activity, analysed nuclides are ^{3}H, ^{90}Sr, and ^{137}Cs.

Except for the sampling point Vltava Prague Podolí, the laboratory receives samples either directly from the supporting organisations (*cf*. chapter 6.2) or *via* postal service. There is a requirement for sampling organisations to follow the accreditation process according to ISO/IEC 17025 standard. The verification team observed the application of this requirement on a Povodí Odry sampling protocol No 609/23 featuring both ILAC and ČIA logos. The supporting organisations accredited for gross beta activity measurements supply these results to VÚV TGM (*e.g.*, protocols No 377/23, 610/23, 404/23).

The samples are numbered according to an internal nomenclature. There is an internal procedure for inserting blank samples occasionally as a means of checking on the staff.

Separate rooms are allocated for sample preparation of low- and high activity (contaminated) samples. Distillation, evaporation, and electrolytic enrichment (ground water) systems are available. In addition, there are separate rooms for radiochemical separation (^{90}Sr) and Radon/Radium in water measurements in case the total-alpha activity limit is exceeded. Hand-held contamination monitors are available for screening incoming samples.

The laboratory counting equipment consist of the following:

- Two automatic proportional counters for total alpha and beta counting of water samples (EMPOS EMS 3 Alpha-beta automat), see Figure 12. The system has 16 sample positions and an automatic system for changing the sample. Alpha and beta emissions are measured separately (change of detector needed: proportional counter *vs* scintillation detector).

[15] Podbabská 2582/30, Prague 6

- Three liquid scintillation counters (Quantulus GCT G220, TriCarb 3120 TR/Sl and Quantulus 1220). Results from Quantulus counters are transferred into LabSys on a USB key.
- Four HPGe detectors (Canberra, liquid N_2-cooled) for gamma spectroscopy (Figure 13). Genie 2000 analysis software is used. Efficiency calibration of the gamma spectroscopy systems is done experimentally using a multi-nuclide standard source, using dedicated standards for each geometry. Monthly calibration controls are carried out, but no long-term trend graphs are used for monitoring system stability, with exception of activity log.
- Alpha/beta analyser with 2 positions (Canberra, not in use for national monitoring)

Calibration of the equipment is based on certified standard sources produced by the Czech Metrological Institute (ČMI). The laboratory participates regularly in intercomparison exercises and proficiency tests organised by the ČMI, IAEA, EC (DG JRC) and SÚRO. Measurement results are uploaded to the MonRaS database in IRIX format.

The laboratory is clean and in good order. Currently there are 5 full time and 2 half time staff members, and one vacancy. No staff or equipment shortages were reported to the verification team, whilst some difficulty finding suitably qualified new personnel was noted. The laboratory would appreciate a new device for gross alpha and gross beta counting, as well as renovating their gamma spectrometry equipment.

The verification team noted that the laboratory carries out a monthly calibration control, but there is no systematic approach to monitoring HPGe measurement system stability parameters (energy, efficiency, and resolution).

The verification team noted that there are some pre-planned arrangements for managing radioactivity samples in an emergency, when the number of samples increases, and the samples may have higher levels of activity than in a routine situation. The laboratory has sufficient space for storing and managing increased number of incoming (radioactive) samples in the event of an emergency, and by reducing the counting times (a measurement lasting 5 minutes provides for LLD in the order of 10 Bq/l or Bq/kg, depending on the isotope) the laboratory's analytical capacity could be increased to facilitate higher sample throughput, but there is no formalised plan for this type of situation. In addition, the number of trained staff is a limiting factor.

The verification team witnessed how the laboratory prepares for an emergency capacity training exercise organised by SÚJB. In these exercises, participating laboratories are required to handle 150-200 incoming samples and carry out as many water radioactivity determinations as possible in 12 hours (emergency working shift). These emergency arrangements may last up to 14 days.

> *The verification team suggests that the T.G. Masaryk Water Research Institute laboratory initiates a practise of maintaining long-term trend graphs of gamma spectroscopy system stability parameters such as energy, efficiency, and resolution (e.g., using FWHM of the ^{60}Co peak at 1332 keV).*
>
> *The verification team suggests that T.G. Masaryk Water Research Institute drafts an internal preparedness plan for laboratory operation in an emergency situation, taking into account the foreseen increased number of incoming samples with possible increased levels of radioactive contamination.*
>
> *The verification team commends the practise or organising capacity exercises to demonstrate analytical capacity during an emergency.*

Figure 12. Automatic proportional counter for total alpha and beta counting at the T.G. Masaryk Water Research Institute

Figure 13. HPGe-detectors at the T.G. Masaryk Water Research Institute

7.4 National Radiation Protection Institute

7.4.1 Radiological laboratory

The verification team verified the Radiological laboratory of the National Radiation Protection Institute (SÚRO)[16]. The laboratory is very well equipped and serves to facilitate research on radiation protection and support the regulator - SÚJB. It consists of a radiochemistry laboratory, spectrometry laboratory, whole body counting laboratory, TLD laboratory and emergency preparedness laboratory. There are about 150 staff in SÚRO; some 20 of them work in the laboratories. Eight additional staff members work on mobile monitoring.

[16] Bartoškova 1450/28, Prague 4

The laboratory is clean and in good order. No staff or equipment shortages were reported to the verification team.

The verification team verified the following analytical equipment:

- Alpha spectrometer (Canberra Alpha Analyst, 12 positions)
- Liquid Scintillation Counter (HIDEX) with digital Pb shield
- Gas chromatography system for radon monitoring (indirect, relative measuring by using organic volatile compounds; United States' Brookhaven National Laboratory patent)
- Automatic alpha/beta counter (EMPOS EMS 3 Alpha-beta automat). The system has 16 sample positions and an automatic system for changing the sample. Alpha and beta particles are measured separately (change of detector needed: proportional *vs* scintillation counter).
- Multi proportional counter (Thermo FHT 7701) for ^{90}Sr measurements
- Alpha/beta low-level counter (Protean MPC 9604) for ^{90}Sr measurements
- Several heavily shielded HPGe detectors for gamma spectroscopy with digital electronics units (Figure 14), typical measurement time is 24 h
- HPGe detector system with an automatic sample changer (QR-coded samples) (Figure 15)

The institute uses machine learning algorithms for improving radiation detection.

The verification team commends the quality and capacity of the SÚRO gamma spectroscopy equipment.

Figure 14. Heavily shielded HPGe detector at SÚRO

Figure 15. Automatic HPGe analysis system at SÚRO

7.4.2 Fixed monitoring equipment

The verification team verified the fixed monitoring equipment at the SÚRO office in Prague. The following equipment are operational:

- Two[17] high-volume air samplers (SnowWhite). One of the samplers is standard unit (Figure 16), and the other one has been fitted with an electrically cooled HPGe detector above the filter for on-line monitoring and alerting (Figure 17). Also, charcoal filters are in place; these are measured if abnormal activity of ^{131}I is detected on the particle filter.
- Automatic dry/wet atmospheric deposition collector 'Pirkko' with 0.5 m^3 collection area (Figure 18). This device automatically detects precipitation and separates dry and wet deposition using a moving lid. The sampling period is one month.
- Dose rate monitoring station number 00013 (Figure 18 and 20). This device is part of the national network.

The verification team commends the sophisticated arrangement for air filter on-line monitoring.

Figure 16. High-volume air samplers at SÚRO

[17] Only one of the two units is in continuous operation due to high electricity costs.

Figure 17. Detector mounted on top of the high-volume sampler air filter

Figure 18. Automatic dry/wet deposition sampler (Pirkko) at SÚRO. The blue detector on the left side is a dose rate monitor part of the national network described in Chapter 7.5.1

7.4.3 Mobile monitoring equipment

The verification team verified the SÚRO mobile monitoring equipment. The main equipment is the following:

- Two monitoring vehicles (Figure 19) equipped with sampling equipment, HPGe detector (sample analysis), air sampler, high volume plastic scintillation detectors, and a large NaI detector (radiation mapping)
- Airborne monitoring system (NaI detector) for installation in a military or police helicopter
- Monitoring drone (research purposes only, special permit to fly up to 20 minutes at a time)
- Handheld equipment
    - Portable HPGe detector for in-situ gamma monitoring
    - Three nuclide identification devices (Indentifinder)

- Surface contamination monitor Berthold LB-124
- Nuclide identification device (RT-30 Super IDENT)
- Neutron detector Berthold LB 6411
- Ground contamination monitor (Mob-DOSE)

In addition, the mobile group has a ground robot, which can be used in remote monitoring and source identification tasks.

No remarks.

Figure 19. SÚRO monitoring vehicle

7.5 State Office for Nuclear Safety

7.5.1 Early warning network

The verification team verified the dose rate monitoring station (measuring unit No. 00011) located on the roof of the SÚJB administration building (Figure 21) and the station (measuring unit No. 00013) located at the SÚRO office (Figure 20). Both stations were operational (ambient dose rate averaging 116 nSv/h at the SÚJB roof at the time of the visit).

There is no precipitation monitoring on these stations. Calibration is carried out once a year. Stations are equipped with phone line/GSM communication and batteries for 72 hours independent operation. Station electronics units are located indoors (Figure 21). Altogether there are four such stations in Prague (Figure 3).

No remarks.

Figure 20. Early warning network station at SÚRO

Figure 21. Early warning network station at the SÚJB office roof (left side) and its electronics unit located indoors (right side)

7.5.2 Integral dose monitoring

The verification team verified the SÚJB arrangements for carrying out radiation integral dose assessment using TLD detectors.

The verification team verified the TLD P1 located at the SÚJB office roof (Figure 22) and the TPD PB located inside the office on the 4th floor. The TDLs are identified with a barcode and are identical to the ones used in personnel dosimetry. They are placed in plastic bottles with no markings.

No remarks.

Figure 22. TLD in a plastic container at the SÚJB office roof

7.5.3 Mobile monitoring equipment

Although SÚRO is mainly responsible for the mobile monitoring in the event of an emergency, the SÚJB also maintains eight sets of mobile equipment for emergency monitoring purposes. The equipment sets are stored in locations of the regional SÚJB offices, and on SÚRO premises in Prague.

The verification team verified the following mobile SÚJB monitoring equipment (Figure 23 and 24) stored at the SÚRO office in Prague:

- Radiation dose monitors (RADOS)
- Radiation dose rate monitors (Thermo Eberline)
- Nuclide identification device (Identifinder GR135 Plus)
- Dose rate monitor with telescope detector (FH 40 F2)
- Portable radiation monitoring system (Mob-DOSE)
- Nuclide identification device (RT-30 Super Ident)
- Surface contamination monitor (Berthold LB 124)
- Contamination and dose rate measurement (RadEye B20-ER) with swipe test analysis box

In addition, the set contains calibration sources and swipe test equipment. SÚJB has altogether 31 persons trained for using the mobile monitoring equipment.

No remarks.

Figure 23. SÚJB mobile monitoring equipment

Figure 24. SÚJB mobile monitoring equipment

8 CONCLUSIONS

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

The information provided and the verification findings lead to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out monitoring of levels of radioactivity in air, water, and soil in Prague and in its vicinity are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out monitoring of levels of radioactivity in air, water, and soil in Prague in the event of a radiological emergency are adequate. The Commission could verify the availability of a representative part of these facilities.

(3) Two technical suggestions are formulated. Notwithstanding these remarks, the verified parts of the monitoring system for environmental radioactivity in place are in conformity with the provisions laid down under the Article 35 of the Euratom Treaty.

(4) The verification summary is presented in the 'Main Conclusions' document that is addressed to the Czech competent authority through the Permanent Representative of the Czech Republic to the European Union.

(5) The Commission services kindly request the Czech authorities to submit a report on any significant changes in the set-up of the monitoring arrangements. Based on this report the Commission will consider the need for a follow-up verification.

(6) The verification team acknowledges the excellent co-operation it received from all persons involved in the activities it performed.

ANNEX 1

VERIFICATION PROGRAMME

EURATOM ARTICLE 35 VERIFICATION IN THE CZECH REPUBLIC

(PRAGUE)

12 – 14 SEPTEMBER 2023

PROGRAMME

Tuesday 12 September

14.00 **Opening meeting at the State Office for Nuclear Safety (SÚJB)**
(Senovážné náměstí 9, Prague 1)

- Welcome and introduction
- European Commission Art. 35 verification activities and programme of the verification mission – V. Tanner, EC DG ENER D.3
- Discussion on the past verifications in the Czech Republic by the Commission
- Other presentations
- Verification planning

15.30 **Overview of radioactivity monitoring arrangements in the Czech Republic and in the Prague region**

- Dose and dose rate monitoring
- Air sampling
- Dry/wet deposition sampling
- Soil sampling
- Water sampling
- Food stuff and feeding stuff sampling
- Mobile monitoring systems
- Emergency monitoring systems
- Public information arrangements

Wednesday 13 September

09.30 **Verifications at the T.G. Masaryk Water Research Institute**
(Podbabská 2582/30, Prague 6)

- Radiological laboratory

13.30 **Verifications at the National Radiation Protection Institute (SÚRO)**
(Bartoškova 1450/28, Prague 4).

- Radiological laboratory
- Fixed monitoring equipment
- Mobile monitoring equipment

Thursday 14 September

09.30 **Verifications at the State Office for Nuclear Safety (SÚJB)**
(*Senovážné náměstí 9, Prague 1*)

- Early warning network
- TLD network
- Fixed monitoring equipment
- Mobile monitoring equipment

13:30 **Additional verifications, if needed**

15:00 **Review of the Czech Republic data in the Commission Art. 35 database**

16.30 **Closing meeting at the State Office for Nuclear Safety (SÚJB)**
(Senovážné náměstí 9, Prague 1)

ANNEX 2

Analytical programme of the National Radiation Protection Institute (SÚRO) laboratory

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
Aerosol	volume activity	Bq/m^3	VDI – G	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb, ^{131}I
Aerosol	volume activity	Bq/m^3	VDI – Sr	^{90}Sr
Aerosol	volume activity	Bq/m^3	VDI - 130	Beta emitting radionuclides
Aerosol	volume activity	Bq/m^3	VDI – Transuranic isotopes	^{238}Pu, ^{239}Pu + ^{240}Pu
Gaseous forms	volume activity	Bq/m^3	VDI – H	^{3}H
Gaseous forms	volume activity	Bq/m^3	VDI – G	^{131}I
Gaseous forms	volume activity	Bq/m^3	VDI – C	^{14}C
Fallout	surface activity	Bq/m^2	VDI – G	^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb
Fallout	surface activity	Bq/m^2	ČSN 75 7612 (BETA)	Beta emitting radionuclides, measurement is carried out only in the laboratory in České Budějovice

Monitoring item	Sampling point	Sampling frequency
Gaseous forms/ iodine	Prague – Bartoškova	Monthly
Gaseous forms/ tritium	Prague – Bartoškova	Monthly
Gaseous forms/ carbon	Prague – Bartoškova	Monthly
Deposition dry and wet	Prague – Bartoškova	Monthly

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclides
Herbage and snow	surface activity	Bq/m^2	VDI – G	^{137}Cs
Soils and herbage	mass activity	Bq/kg	VDI – G	^{40}K, natural radionuclides
	surface activity	Bq/m^2		^{137}Cs
Soils - in situ	mass activity	Bq/kg	Spectrometry *in situ*	^{40}K, natural radionuclides
	surface activity	Bq/m^2		^{137}Cs

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
Rainwater	volume activity	Bq/l	VDI – H	^{3}H

Monitoring item	Sampling point	Sampling frequency
Rainwater	Prague – Bartoškova	Monthly

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
Cow milk consumer	volume (mass) activity	Bq/l (Bq/kg)	VDI –G	^{137}Cs
			VDI – Sr	^{90}Sr
Raw cow milk	volume (mass) activity	Bq/l (Bq/kg)	VDI –G	^{137}Cs
			VDI – Sr	^{90}Sr
Milk powder (for adults)	mass activity	Bq/kg	VDI –G	^{137}Cs
			VDI – Sr	^{90}Sr
Goat milk	volume (mass) activity	Bq/l (Bq/kg)	VDI –G	^{137}Cs
Sheep milk	volume (mass) activity	Bq/l (Bq/kg)	VDI –G	^{137}Cs
Milk products	mass activity	Bq/kg	VDI –G	^{137}Cs

Monitoring item	Sampling point	Sampling frequency
Cow milk-consumer´s	Prague and Central Bohemian Region (Středočeský kraj)	2 x per year
Milk powder (for adults)	Prague and Central Bohemian Region (Středočeský kraj)	2 x per year

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
All-day mixed diet (proportionate part)	mass activity	Bq/kg	VDI – G	^{137}Cs
			VDI – Sr	^{90}Sr
All-day mixed diet (restaurants and diners)	mass activity	Bq/kg	VDI – G	^{137}Cs
			VDI – Sr	^{90}Sr
All-day mixed diet (consumption basket)	activity per day	Bq/day	VDI – G	^{137}Cs
			VDI – Sr	^{90}Sr

Monitoring item	Sampling point	Sampling frequency
All-day mixed diet (consumption basket)	Prague Region	2 x per year

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
Mushrooms	mass activity	Bq/kg	VDI –G	^{137}Cs
Wild berries	mass activity	Bq/kg	VDI –G	^{137}Cs
Slaughter meat	mass activity	Bq/kg	VDI –G	^{137}Cs
Cereals	mass activity	Bq/kg	VDI –G	^{137}Cs
Root crops	mass activity	Bq/kg	VDI –G	^{137}Cs
Fruit	mass activity	Bq/kg	VDI –G	^{137}Cs
Food products	mass activity	Bq/kg	VDI –G	^{137}Cs

Monitoring item	Measured physical quantity	Unit	Sample measurement procedure	Radionuclide
Fish	mass activity	Bq/kg	VDI –G	^{137}Cs
Eggs	mass activity	Bq/kg	VDI –G	^{137}Cs
Vegetable	mass activity	Bq/kg	VDI –G	^{137}Cs
Agricultural crops	mass activity	Bq/kg	VDI –G	^{137}Cs
Venison	mass activity	Bq/kg	VDI –G	^{137}Cs

Monitoring item	Sampling point	Sampling frequency
Slaughter meat– poultry	Prague and Central Bohemian Region	4 x per year
Slaughter meat– pork	Prague and Central Bohemian Region	4 x per year
Slaughter meat– beef	Prague and Central Bohemian Region	4 x per year
Cereals – barley	Prague and Central Bohemian Region	1 x per year
Cereals – corn	Prague and Central Bohemian Region	1 x per year
Cereals – oat	Prague and Central Bohemian Region	1 x per year
Cereals – wheat	Prague and Central Bohemian Region	1 x per year
Cereals – rye	Prague and Central Bohemian Region	1 x per year
Cereals – triticale	Prague and Central Bohemian Region	1 x per year
Root crops – potatoes	Prague and Central Bohemian Region	2 x per year
Fruit – apple	Prague and Central Bohemian Region	2 x per year
Food products – flour	Prague and Central Bohemian Region	2 x per year
Food products – oat flakes	Prague and Central Bohemian Region	2 x per year
Vegetable – onion	Prague and Central Bohemian Region	1 x per year
Vegetable – carrot	Prague and Central Bohemian Region	1 x per year
Vegetable – tomatoes	Prague and Central Bohemian Region	1 x per year
Vegetable – cabbage	Prague and Central Bohemian Region	1 x per year

ANNEX 3

Analytical programme of the T.G. Masaryk Water Research Institute

Place	Basin	Monitoring item	Nuclide	Frequency	Note
ÚV Monaco (VN Křižanovice)	Labe	water supply stations sludge	^{137}Cs	year	
ÚV Plav (VN Římov)	Vltava	water supply stations sludge	^{137}Cs	year	
VN Římov (Malše)	Vltava	dams & ponds sediments	^{137}Cs	year	
VN Křižanovice (Chrudimka)	Labe	dams & ponds sediments	^{137}Cs	year	
VN Fláje (Flájský potok)	Ohře	dams & ponds sediments	^{137}Cs	year	
ÚV Hulice (VN Švihov)	Vltava	waterworks (water stations)	^{137}Cs, ^{3}H	quarterly	
ÚV Monaco (VN Křižanovice)	Labe	waterworks (water stations)	^{137}Cs, ^{90}Sr, ^{3}H	quarterly/year	^{90}Sr/year
ÚV Plav (VN Římov)	Vltava	waterworks (water stations)	^{137}Cs, ^{90}Sr, ^{3}H	quarterly/year	^{90}Sr/year
VN Švihov (Želivka)	Vltava	water station reservoirs	^{137}Cs, ^{3}H, beta/^{90}Sr	quarterly/year	^{90}Sr/year
VN Římov (Malše)	Vltava	water station reservoirs	^{137}Cs, ^{3}H, beta/^{90}Sr	quarterly/year	^{90}Sr/year
VN Křižanovice (Chrudimka)	Labe	water station reservoirs	^{137}Cs, ^{3}H, beta/^{90}Sr	quarterly/year	^{90}Sr/year
Vltava - Prague - Podolí	Vltava	water streams	^{3}H	week	
Labe - Hřensko	Labe	water streams	^{137}Cs, ^{3}H, beta/^{90}Sr	quarterly/year	^{90}Sr/year
VN Římov (Malše)	Vltava	fish	^{137}Cs	year	
VN Křižanovice (Chrudimka)	Labe	fish	^{137}Cs	year	

ANNEX 4

Analytical programme of the State Veterinary Institute Prague

Subject	Monitoring item	Sample	Samples/year
SVÚ	Mixed diet items	beef meat	50
		pork meat	50
		poultry meat	50
		fish and venison	50
		rabbit meat	10
	Milk	raw, dried milk	50
	Food products	honey	15
SVÚ (collecting and measuring)			**275**
SZPI	Mixed diet items	Cereals, pastry, fruit, vegetable, potatoes	28
ÚKZUZ	Feed	hay, haylage, silage	50
VÚLHM	Mixed diet items	wild berries	15
		mushrooms	30
Samples			123
SVÚ measurement			**398**