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Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

SLOVENIA
Ljubljana

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

6 - 7 June 2022

Reference: SI 22-03

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	Ljubljana, Slovenia
DATES	6 – 7 June 2022
REFERENCE	SI 22-03
TEAM MEMBERS	Ms Elena Luminita DIACONU (Team leader) Ms Faidra TZIKA
REPORT DATE	18 May 2023
SIGNATURES	

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Annex 1	Verification programme

Abbreviations

ACPDR	Administration of Republic of Slovenia for Civil Protection and Disaster Relief
ALMERA	Analytical Laboratories for the Measurement of Environmental Radioactivity network (coordinated by IAEA)
AMS	Automatic aerosol monitors system
CBRN	Chemical, Biological, Radiological, Nuclear
EC	European Commission
ELME	Ecological Laboratory with Mobile Unit
EU	European Union
EURDEP	EUropean Radiological Data Exchange Platform
GM	Geiger-Müller
GDR	Gamma Dose Rate
HPGe	High-Purity Germanium detector
IAEA IOS	International Atomic Energy Agency Institute of Occupational Safety
JSI	Jožef Stefan Institute (Ljubljana)
LIMS	Laboratory Information Management System
LMR	Laboratory for Radiation Measuring Systems and Radioactivity Measurements
MCA	Multichannel Analyser
MDA	Minimum Detectable Activity
NPP	Nuclear Power Plant
QA/QC	Quality Assurance / Quality Control
REM	EC Radioactivity Environment Monitoring database
QA/QC	Quality Assurance / Quality Control
RVO	“Radioaktivnost V Okolju” (in Slovenian)
SNSARVO	Slovenian Nuclear Safety Administration “Radioaktivnost V Okolju” (in Slovenian)
SRPA	Slovenian Radiation Protection Administration
SNSA	Slovenian Nuclear Safety Administration
TLD	Thermoluminescence Dosimetry
TSO	Technical Support Organisation
TLD	Thermoluminescence Dosimetry

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 Slovenia of its decision to conduct an Article 35 verification in a letter addressed to the Slovenian Permanent Representation to the European Union. The Slovenian Nuclear Safety Administration (SNSA), under Ministry of Environmental and Spatial Planning was designated to lead the preparations for the visit.

2.2 DOCUMENTS

To assist the verification team in its work, the SNSA supplied replies to the preparatory questionnaire before the visit[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.

[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 3 June 2022

2.3 PROGRAMME OF THE VISIT

The Commission and the Monitoring Section of the Radiation Safety and Material Division of the Slovenian Nuclear Safety Administration discussed and agreed on a programme of verification activities (Annex 1) in line with the Commission Communication of 4 July 2006.

The opening meeting included an introduction by the Commission of the scope of the verification. The meeting on the second day at the SNSA included presentations on the Slovenian radiation monitoring system and on the national rules on radioactivity monitoring[4], which provide the strategy, design and requirements of the national monitoring program, as well as the methods and provisions for authorisation of laboratories, and certification of products. The verification team pointed to the quality and comprehensiveness of all the presentations and documentation received.

The team carried out the verifications in accordance with the programme in Annex 1. The team met the following representatives of the Slovenian Nuclear Safety Administration (SNSA) and other involved parties:

- Dr Samo Tomažič, Head of Monitoring Section, SNSA
- Mr Michel Cindro, Monitoring Section, SNSA
- Dr Gregor Omahen, Head of laboratory, Institute of Occupational Safety
- Mr Marko Giacomelli, expert councillor, Institute of Occupational Safety
- Dr Benjamin Zorko, Head of ICMIS, Jožef Stefan Institute (JSI)
- Mr Marko Štrok Head of radiochemical laboratory of Department of Environmental Sciences of JSI at the Research Reactor premises.

[4] Rules on radioactivity monitoring (Official Gazette of the Republic of Slovenia, No. 27/18) http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV13174

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING IN SLOVENIA[5]

3.1 LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

The Slovenian legislation, which forms the basis for environmental radioactivity monitoring is the following:

- Act on Ionising Radiation Protection and Nuclear Safety (ZVISJV-1A) - OJ RS No. 76/17, 26/19
- Rules on radioactivity monitoring (JV10) - OJ RS No. 20/07, 97/09, 27/18
- Decree on radiation activities (UV1) - OJ RS No 48/04, 9/06, 19/18
- Decree on the national radon programme (UV4) - OJ RS No 18/18, 86/18
- Decree on the doses limit, reference levels and radioactive contamination (UV2) - OJ RS No 18/18
- Decree on the reduction of exposure due to natural radionuclides and existing exposure situations (UV5) - OJ RS No 38/18

3.2 LEGISLATIVE ACTS REGULATING RADIOLOGICAL SURVEILLANCE OF FOODSTUFFS

The Slovenian legislation, which forms the basis for food radioactivity monitoring is the following:

- Act on Health and Hygiene Safety of Foodstuffs and Products and Materials Coming in Contact with Foodstuffs (OJ RS, No. 52/2000, 42/2002, 47/2004)
- Decree on carrying out Regulations of the Council of the European Union and the European Commission on radioactive contamination of foodstuffs and feedstuffs (OJ RS No. 52/2006, 38/10)

3.3 LEGISLATIVE ACTS REGULATING RADIOACTIVITY CONTENT IN DRINKING WATER

The Slovenian legislation, which forms the basis for drinking water radioactivity monitoring is the following:

- Regulations on drinking water (OJ RS, No. 19/2004, 35/2004, 26/2006)
- Rules on monitoring radioactivity in drinking water (OJ RS, No. 74/15)
- Rules on the monitoring of radioactivity in water intended for human consumption (OJ RS No. 74/15, 76/17)

3.4 LEGISLATIVE ACTS ON ENVIRONMENTAL MONITORING IN EMERGENCY SITUATIONS

The Slovenian legislation, which forms the basis for environmental radioactivity monitoring in the event of an emergency is the following:

- National Emergency Response Plan for Nuclear and Radiological Accidents, version 3.0 - No 84300-4/2010/3
- Decree on the content and elaboration of protection and rescue plans - OJ RS No 24/12, 78/16, 26/19
- Protection Against Natural and Other Disasters Act (ZNOrg) - OJ RS No 51/06, 97/10, 21/18

[5] http://www.arhiv-spletisc.gov.si/

3.5 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below presents 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.

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
- 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 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
- *Guidelines for drinking-water quality*, 4th ed. 2017, incorporating the 1st addendum, World Health Organisation (WHO)

4 BODIES HAVING COMPETENCE IN RADIOACTIVITY MONITORING IN LJUBLJANA

4.1 INTRODUCTION

The main authority in Slovenia in charge of the monitoring of radioactivity in the environment is the Slovenian Nuclear Safety Administration (SNSA), part of Ministry of Environmental and Spatial Planning, which is the nuclear safety regulatory authority. The SNSA operates the early warning network of the country, while the laboratory-based monitoring is conducted by authorised technical support organisations (TSO).

The authority in charge of monitoring of radioactivity in foodstuff and drinking water is the Slovenian Radiation Protection Administration (SRPA) part of Ministry of Health, which is the radiation protection authority in the country. The monitoring is conducted for SRPA by authorised TSOs.

Monitoring of radioactivity in feeding stuff is under the responsibility of the Directorate for Food Safety of the Ministry of Agriculture, Forestry and Food. The actual monitoring is conducted by authorised TSOs.

Environmental and foodstuff radioactivity monitoring during an emergency is under the responsibility of the Administration of Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR). The emergency monitoring in Slovenia is conducted by the ACPDR with its own mobile units, as well as with mobile units of contracted TSOs.

In addition to the national routine environmental radiological monitoring programme, systematic inspection of industrial activities involving NORM and measurement of radon in living and working environments are conducted in Slovenia, under the responsibility of the SRPA. The measurements are performed by approved technical support organisations (TSOs).

4.2 SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

The Slovenian Nuclear Safety Administration (SNSA) is the national competent authority for monitoring radioactivity in the environment, within the Ministry of the Environment and Spatial Planning. The SNSA is one of the two bodies having responsibilities in environmental monitoring in Slovenia. The SNSA performs professional, administrative, supervisory and development tasks in the areas of radiation and nuclear safety, radiation practices and the use of radiation sources (except in healthcare or veterinary medicine), protection of the environment against ionising radiation, physical protection of nuclear material and facilities, non-proliferation of nuclear weapons, and protection of nuclear goods. The authority

- prepares regulation on radioactivity monitoring, establishes the national monitoring programme for Slovenia and approves a monitoring programme in the vicinity of nuclear and radiation facilities;
- authorizes professional and research organisations to carry out radioactivity monitoring (together with the SRPA);
- confirms the release control programme and monitors radioactive releases from nuclear and radiation installations;
- reports on radioactivity and radiation in the environment to the Government and to the National Assembly and informs the public through annual reports.

In addition, the SNSA regularly forwards data on radioactivity measurements to the EURDEP system and to neighbouring countries.

4.3 SLOVENIAN RADIATION PROTECTION ADMINISTRATION

The Slovenian Radiation Protection Administration (SRPA) is a national authority within the Ministry of Health. The SRPA performs professional, administrative, development and supervisory tasks related to radiation practices and the use of ionising radiation sources in human and veterinary medicine and to

the protection of public against the harmful effects of ionising radiation. It recognises and approves experts who carry out professional tasks in the field of ionising radiation. It provides systematic reviews and measurements of radon, as well as contamination monitoring of foodstuffs and drinking water. It is also involved in raising people's awareness of limitation, reduction, and prevention of the harmful health effects of non-ionising radiation.

4.4 INSTITUTE FOR OCCUPATIONAL SAFETY

The Institute for Occupational Safety (IOS) is a private company that deals with occupational safety. Its main laboratory is in Ljubljana. The Radiation Protection Unit laboratory of the IOS is involved in routine and emergency monitoring of air, water, soil, vegetation, and food. The laboratory is authorised by SNSA[6] for radiological monitoring of foodstuff and drinking water in both normal and emergency situations, as well as for emergency monitoring of the environment.

4.5 JOŽEF STEFAN INSTITUTE

The Jožef Stefan Institute (JSI) is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff, of about 1200 members, are specialized in natural sciences, life sciences and engineering. At the JSI, there are two departments and two special institutional units related to the field of the radiation protection:

- Radiation Protection Unit (RPU) – SVPIS
- Department of Low and Medium Energy Physics (F2)
- Department of Environmental Sciences (O2)
- Milan Čopič Nuclear Training Centre (ICJT)

The departments F2 (ICMIS) and O2 (Radiochemistry) are mandated to carry out monitoring of radioactivity in the environment by Authorisation No 35400- 3/2019/12 of 14 January 2020 issued by the SNSA. The JSI ICMIS laboratories (under department F2) perform monitoring of air, water, soil, vegetation and food.

JSI operates a research reactor (General Atomics TRIGA®) at Ljubljana-Podgorica/Brinje. The reactor centre was built in 1966 and serves a multitude of purposes. The installations and support services at the Reactor Centre include the Energy Efficiency Centre, the Nuclear Training Centre, the Reactor Infrastructure Centre and the Radiation Protection Group.[7]

The laboratory for radiochemistry of department O2 at the research reactor premises performs radiochemical measurements on environmental samples (H-3, C-14, Sr-90/89, U-238, U-234, U-235, Th-230, Th-232, Th-228, Ra-228, Ra-226, Pb-210, Po-210, Am-241, Cm-244, Pu-239/240 and Pu-238).

[6] While SNSA has the lead in the authorisation process and issues the authorisation, it is signed by both entities, SNSA and SRPA.

[7] While the verification team in 2011 had been informed that the reactor might be shut down in 2016, the reactor is still operating.

5 RADIOACTIVITY MONITORING IN LJUBLJANA

5.1 INTRODUCTION

The national environmental radioactivity monitoring programme in Slovenia is designed by the SNSA as the nuclear safety regulatory authority. The monitoring programme covers the following media: air, ground, surface waters, precipitation, drinking water, foodstuffs and feeding stuffs. The SNSA is operating the on-line national network, comprising 70 gamma dose rate probes and three automatic aerosol monitoring stations located in Ljubljana, Krško, and in Drnovo.

As Ljubljana has no specific monitoring plan, measurements are made within the frame of the state - wide program for monitoring environmental samples, food, and feed.

5.2 EARLY WARNING NETWORK

The early warning network in Slovenia (Figure 1) includes a system operated by the SNSA and two other systems, one part of the Krsko NPP monitoring network and one part of the Triga Research Reactor monitoring network. The network is an online system operated by the SNSA comprising 70 gamma dose rate (GDR) probes spread in the country and 3 spectrometer systems. From these, 13 GDR's are part of the Krsko NPP, 56 are part of the national monitoring and one is installed on the Research reactor premises. All 70 GDR stations transmit data to the EURDEP system. The early warning system provides gamma dose rate and precipitation data on a continuous basis[8].

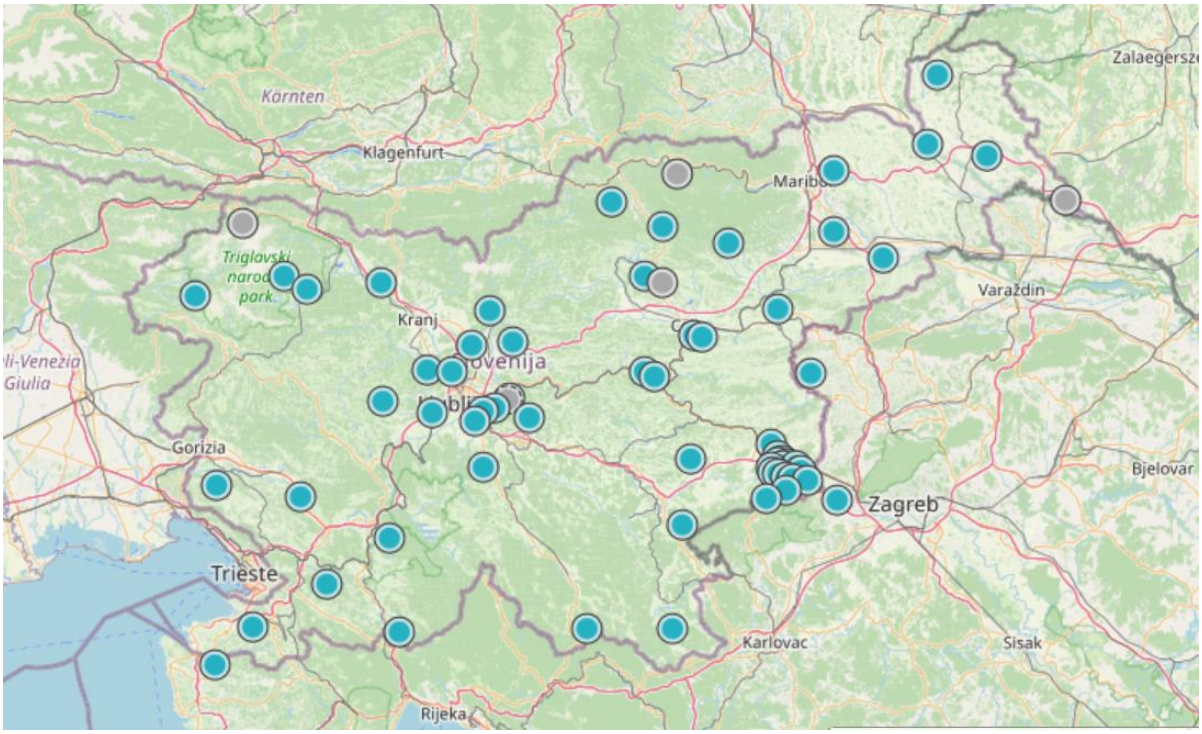

Figure 1. Early warning network in Slovenia (real time monitoring)[6]

In the Ljubljana region, four gamma dose rate stations are installed, as shown in Figure 2, at the JSI garden (Figure 3 left), at the meteorological institute premises, at the Research reactor premises (Figure 3 right), and at Hrastje (Figure 2 second from the right).

[8] https://www.radioaktivnost.si/rvo_public/RVO/Map

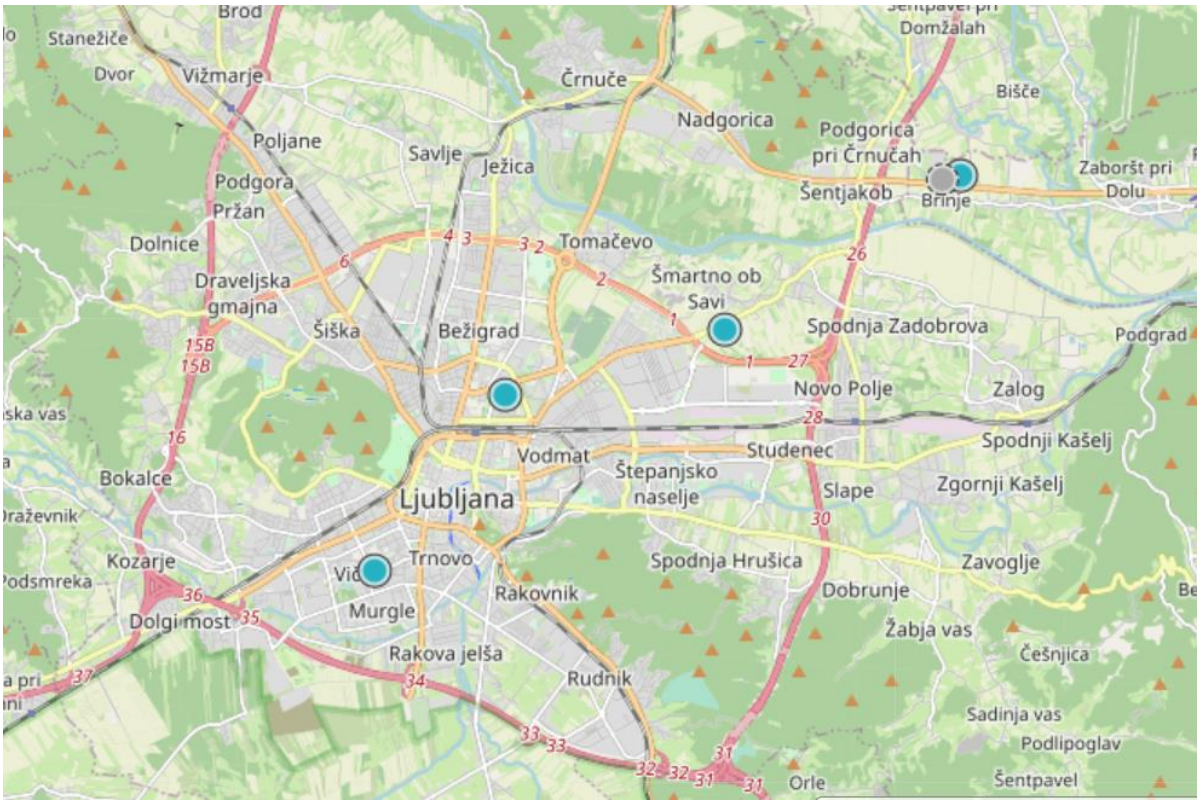

Figure 2. Early Warning Network in the Ljubljana region (blue circles)

Figure 3. GDR MIRA at the Josef Stefan Institute (left) and at the Research reactor premises (right)

The Slovenian telemetric network comprises GDS MFM203 type monitors, but the entire system will be replaced with new MIRA ENVINET GDR probes. The GDS MFM203 is a portable-size, self-sustained local monitor for continuous monitoring of gamma radiation in the environment. When connected to a data communication link, it serves as a smart field unit of the real-time automatic early warning network. The monitor is supplied with two energy-compensated Geiger Muller (GM) probes of different sensitivities, covering dose-rates from the normal background to the accident levels. The monitor can be linked to the communication network; it has a built-in rechargeable battery and a possibility to connect a meteorological sensor.

The GDR probes have a range of dose rate for the standard version with probes A and B from 10 nSv/h to 10 Sv/h, and for the version with probe A from 10 nSv/h to 3 mSv/h.

In addition, an automatic fixed spectroscopic gamma detector ENVINET SARA is installed at the research reactor premisses as part of the national monitoring programme (Figure 4). This online NaI(Tl) -based spectroscopic in-situ gamma detector measures and analyses continuously the gamma spectra. SARA is able to detect even minor changes of the composition of the nuclear spectra in the environment. It performs fast detection and identification of artificial radionuclides in the environment. SARA also measures the total and nuclide specific gamma dose rate in units of the ambient dose equivalent rate H*(10).

Figure 4. ENVINET SARA – fixed spectroscopic gamma detector, at the Research reactor premises

Control centre of the telemetric network

The telemetric system is operated by the SNSA. All data on radioactivity monitoring are collected in a dedicated application called Radioactivity in the Environment (RVO, “Radioaktivnost V Okolju” in Slovenian). In addition to basic functions such as archiving, displaying, and informing the SNSA’s

experts, the portal can be used in emergency situations. If the system detects elevated radiation values, the portal displays, in real-time, data from in-field measurements taken by mobile units or by the SNSA employees. The data are transmitted automatically and made available in real-time to the public on the RVO web portal[9]. The RVO system can be also used for preparation of radiological reports. The system sends radiological data every 30 minutes to EURDEP as well as to Austria, Croatia, and Hungary, under bilateral agreements.

The RVO system can assimilate any kind of data, subject to dedicated import mask. Data from the three aerosol systems, from the deposition collectors, GDR's and meteorological parameters are available and can be consulted at the same time. Data transmission depends on the infrastructure available on-site (wired or wireless). The servers used are running in the government cloud.

The meteorological parameters measured by the meteorological stations are also transmitted to the SNSA control centre every 30 min. In addition, the data measured by the mobile units belonging to the ACPDR (dose rate and concentration of activity in air) are transmitted to the National Notification Centre and from there to the SNSA, as soon as they are available.

5.3 AMBIENT RADIATION DOSE

Slovenia is monitoring the ambient radiation dose using thermoluminescence dosimetry (TLD). There are in total 50 TLDs spread in Slovenia; in Ljubljana one TLD is placed at the meteorological institute premises as part of national program. TLD's are also placed at the premises of several facilities as part of the respective operational monitoring programs (Research reactor, LILW storage facility, Krško NPP). The location of the TLD installed in Ljubljana is shown in Figure 5.

The TLD system was developed in-house at the JSI (Figure 6), based on the modified standard method IEC 62387. The TLDs measure ambient dose equivalent H*(10); the measurement range of the system is from 0,0075 mSv to 5 Sv for energy range 40 keV – 1,2 MeV. The dosimeter types are TLD-400 (CaF2:Mn) and TLD-100H/MCPN (LiF:Mg,Cu,P).

The TLDs are read two times a year in the Dosimetry Laboratory of the JSI (Figure 7). The same system is used also for personal dosimetry. In the TLD laboratory, three employees perform approximately 900 readings/month (10000/year), from which around 100/month are readings of environmental TLDs and the rest are TLDs used for individual dosimetry.

[9] https://www.radioaktivnost.si/rvo_public/RVO/Map

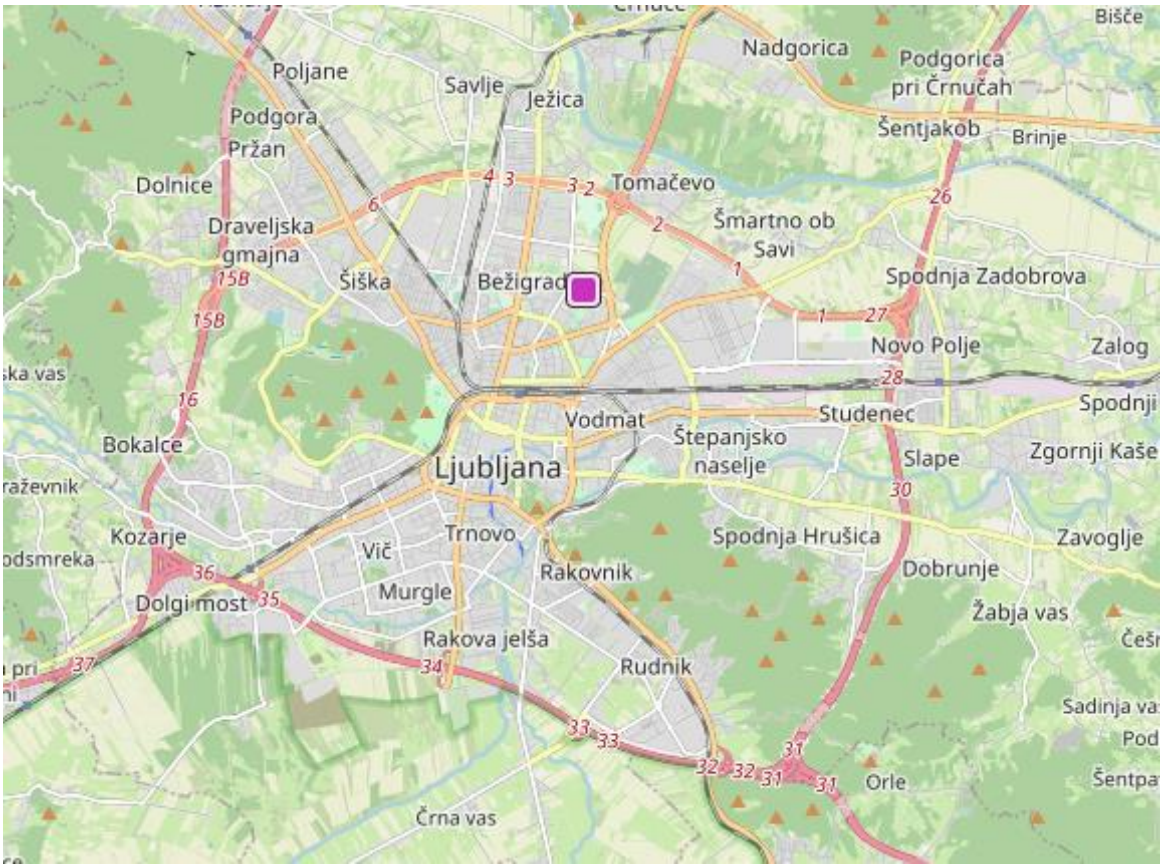

Figure 5. TLD in Ljubljana at the meteorological institute premises (national monitoring program)

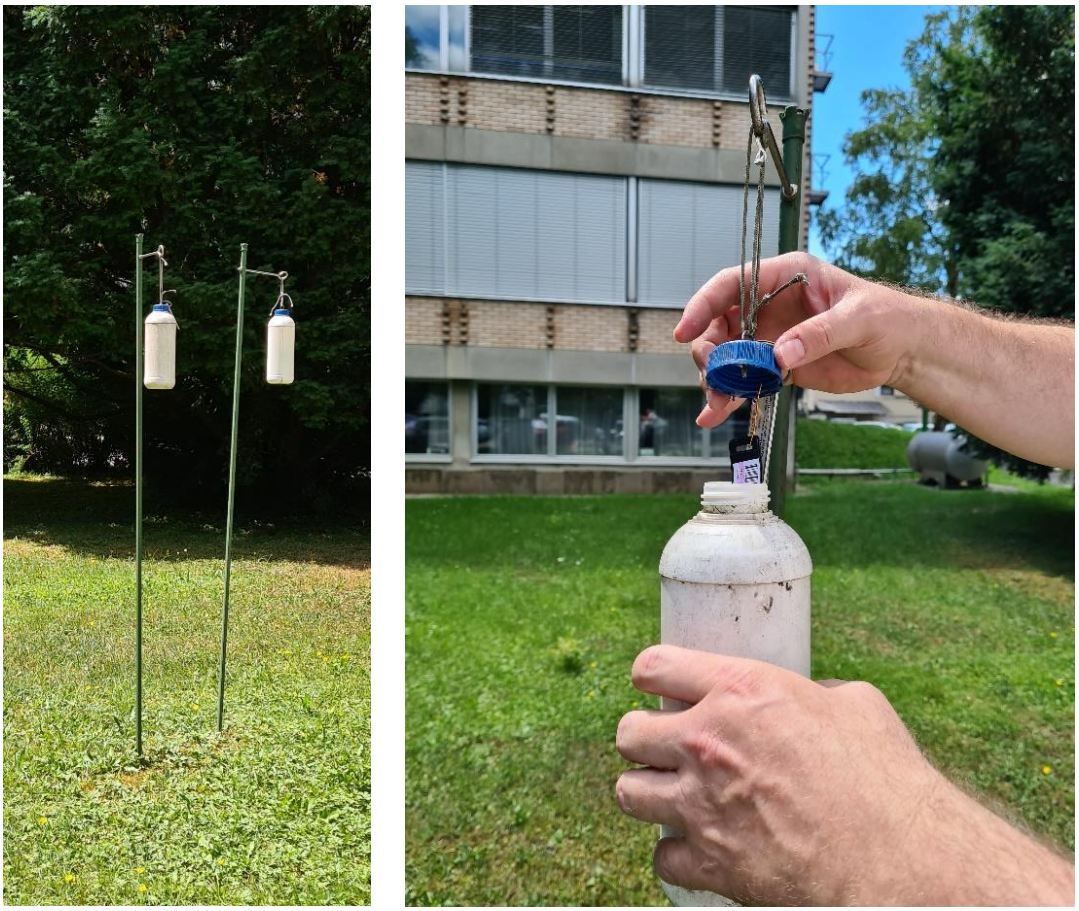

Figure 6. TLD dosimeters in plastic bottle housing at the JSI garden

Figure 7. TLD reader at the TLD laboratory of the JSI (ICMIS)

5.4 AIR

Radioactivity concentration in air in Slovenia is monitored with air samplers and with on-line aerosol monitors. There are three air samplers installed in Slovenia as part of the environmental monitoring programme, one in Ljubljana at the JSI (Figure 8). On-line aerosol monitors are situated at the Research reactor centre near Ljubljana and in the vicinity of the Krško NPP (2). A few other off-line samplers are installed around the Krsko NPP as part of the NPP operational programme.

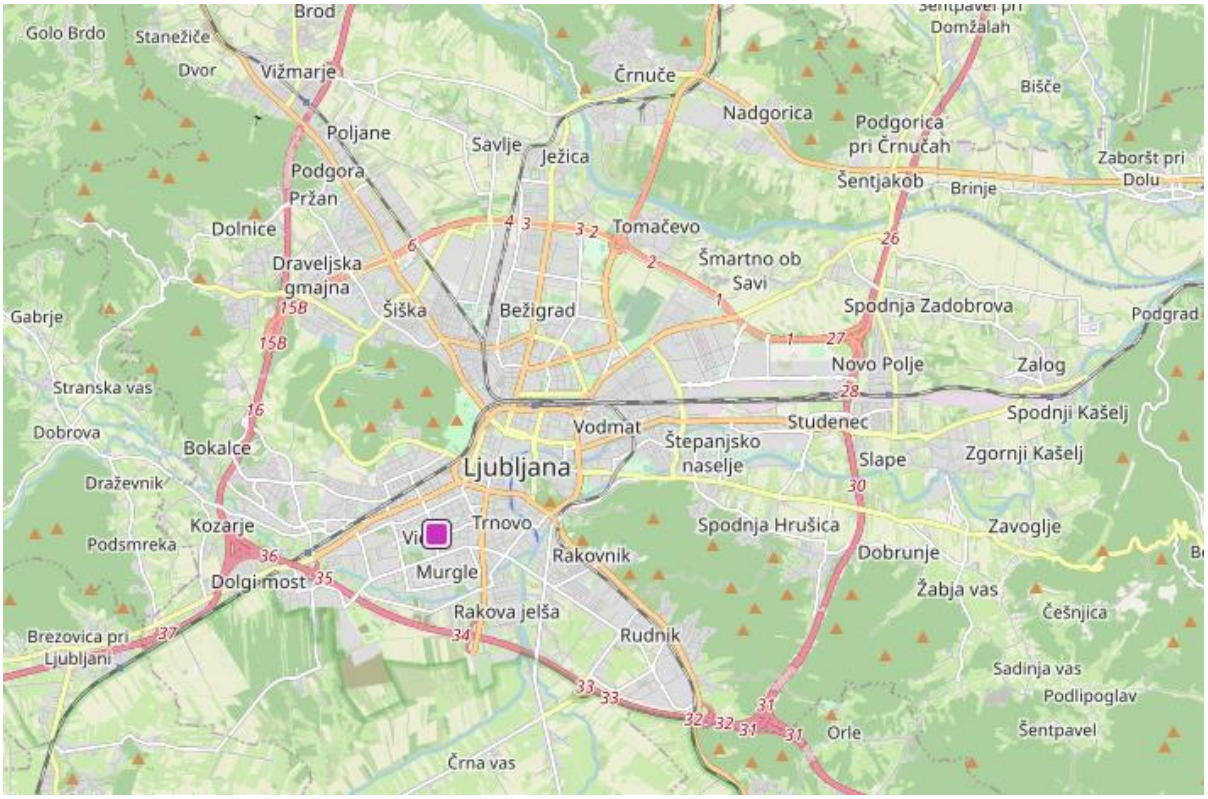

Figure 8. Location of the air sampler in Ljubljana

5.4.1 Air sampler at the JSI

The air sampler at the JSI (Figure 9) is a high-volume aerosol pump (150.000 m^3/month). The in-house built single-branch air sampler uses a concertinaed fiberglass filter of an area of 0.87 m^2. At the nominal air flowrate of 216 m^3 /h, the retention efficiency of the filter is 99.99 % for particles larger than 0.3 µm. The system works continuously 24 hours per day. A flow rate meter is used to measure the total air flow in the sampling period. The sampling period for aerosol filters is one month.

Figure 9. High volume air sampler of the JSI

5.4.2 Air sampler at the IOS

The high-volume air sampler installed at the IOS (Figure 10) is not in operation and is not intended for use.

Figure 10. High volume air sampler at the IOS

5.4.3 On-line aerosol monitor

In Slovenia there are three on-line automatic aerosol monitoring systems. The systems are of type AMS 02, manufactured by Bitt technologies Austria (Figure 12). One system is installed in Ljubljana at the

research reactor premises (location indicated by the red arrow in Figure 11), the second one in Krsko, and the third one in Drnovo, close to the Krsko NPP. The systems were received from the IAEA, through technical help projects and the Republic of Austria, as part of the cooperation agreement between the two countries. The aerosol monitors are operated by the SNSA and maintained by the manufacturer every 3 months. Collected data are transmitted to the RVO system and to EURDEP. Data are shared also with Austria as part of the bilateral cooperation agreement.

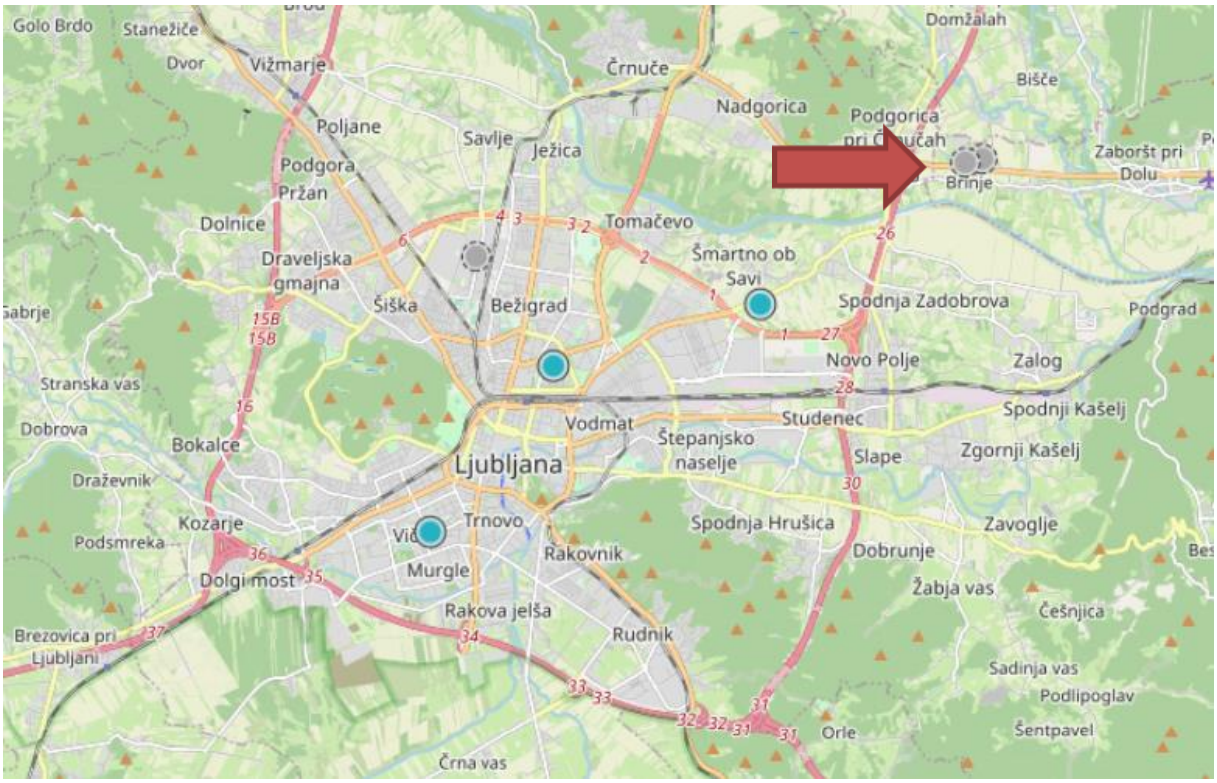

Figure 11. Location of the on-line aerosol monitor in Ljubljana (red arrow)

The automatic air radioactivity monitoring stations provide alpha and beta radioactivity measurements on aerosol filters using a PIPS detector of 1700 mm² and resolution 55 keV for α particles emitted by Am-241) and < 30 keV for betas. The station in Drnovo has a HPGe gamma spectrometry system for specific gamma emitting radionuclide analysis on filters used for the monitoring of aerosols. Both Brinje and Krško NPP stations have a low-resolution gamma spectroscopy system for measuring the filters. All stations can also perform low-resolution gamma spectrometry measurements on special filters for elemental iodine and on activated charcoal filters for organic iodine using NaI(Tl) detectors with automatic weekly calibration. The integration time is 1 h in normal conditions; in case of alarm the time is reduced to 5 min. Typical LLD for measurement of aerosols is 1 Bq/m^3 (for Cs-137 and I-131).

The system at Brinje has two NaI(Tl)- 2x2“ Na(Tl) detectors with resolution 8 % (at 662 keV of Cs-137). The system’s flow rate is 7.5 m^3/h. The system measures radon, alpha-beta, total gamma, Cs-137 and I-131 concentrations, in Bq/m^3. The measurement results are transmitted on-line to RVO system and to EURDEP daily every hour. The system is equipped with a remote control unit, which enables communication from and to the central unit. Testing of detectors is performed using calibration filters. Filters can be extracted for more precise off-line analysis. Under normal conditions, the filters are changed every 24 h. Measurements are conducted in 5 min intervals. After three consequent abnormal measurements, the device switches automatically to intensive mode measurements (i.e. filter change every hour).

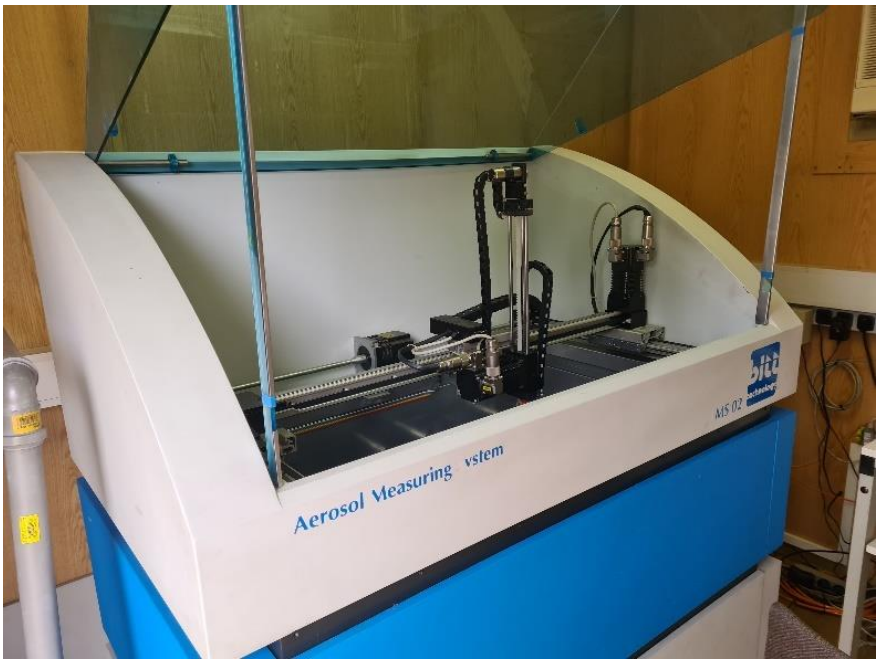

Figure 12. On-line aerosol monitor at the research reactor premises

5.5 ATMOSPHERIC DEPOSITION

In Slovenia radioactivity concentration in atmospheric deposition (rain and dust) is monitored by collecting wet and dry deposition (fallout dust and precipitation separately) and by measuring the samples in the laboratory. The collectors are placed in different regions in Slovenia: in Ljubljana, Krško, Dobova, and Brege. In Ljubljana there are two wet collectors and two dry collectors, one at the JSI and one at the IOS (Figure 13).

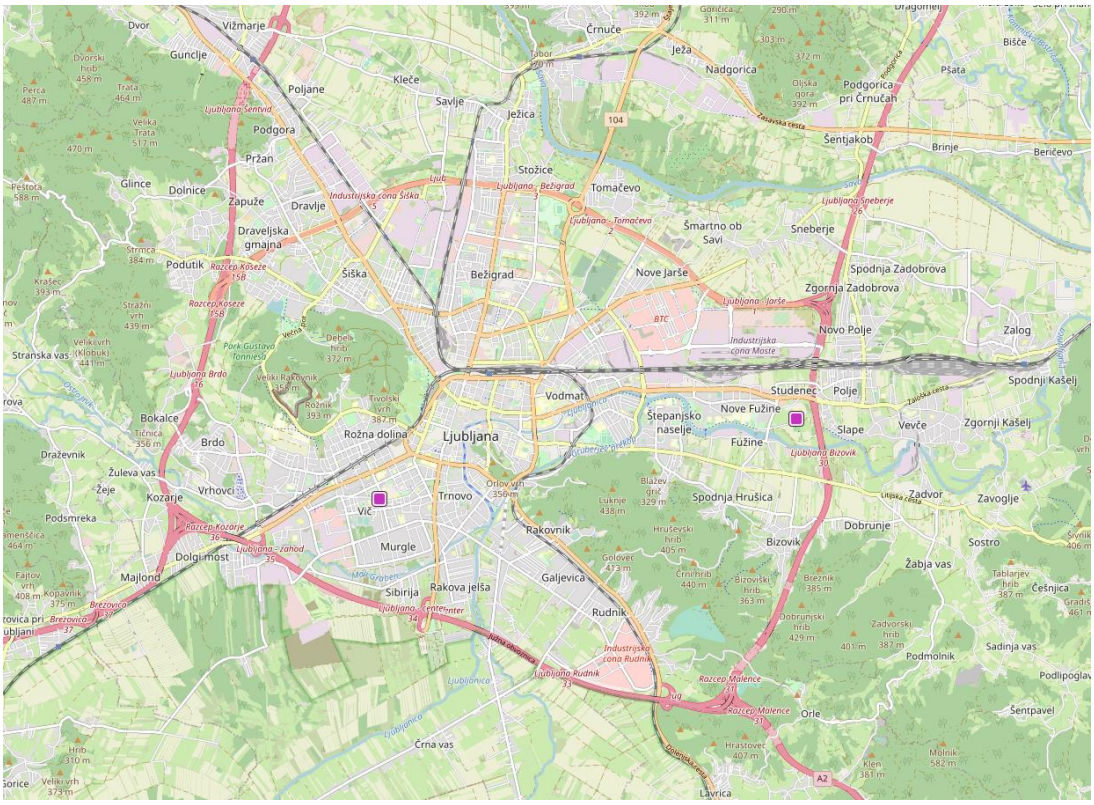

Figure 13. Location of dry/wet collectors in Ljubljana

JSI

Two atmospheric deposition wet and dry collectors are installed at the JSI. The wet deposition/precipitation collector is a stainless steel funnel of an effective area of 0.25 m^2 that is placed 1 m over the ground. The precipitation is continuously sampled over a month in a 50 L replaceable plastic container (Figure 14 left). The dry deposition collector is an air dust collector (sticky plate) of an area of 0.3 m^3 with vaseline deposited on the plate (Figure 14 right).

Samples are collected monthly and sent to the laboratory for analyses of natural and artificial gamma emitters, Sr-90 and H-3.

Figure 14. Atmospheric wet deposition (left) and dry deposition collectors at the JSI (right)

IOS

Two precipitation collectors are installed in the IOS garden (Figure 15). The samplers collect the fallout from the 0,25 m^2 surface. The water from the collecting vessel goes to a canister (blue canister on Figure 15). The metal mesh protects the sampling vessel from insects and birds.

Figure 15. Atmospheric dry and wet deposition collectors at the IOS

5.6 WATER

5.6.1 Surface waters

Radioactivity of surface water in Slovenia is monitored in inland waters. Sampling locations are on eight rivers of the country. In Ljubljana, the river water samples are collected twice a year in one location of the river Sava, at low and high flow rate (Figure 16). The water samples are analyzed in the IOS laboratory (Figure 17). A sample of 30 - 50 L of water is concentrated by evaporation below 70 degrees Celsius to a 10-50 g dry residue. Radionuclides tested in surface waters are natural and artificial gamma emitters, Sr-90, and H-3. In addition, I-131 is investigated in all river samples, typically found to be in correlation with releases from major medical facilities.

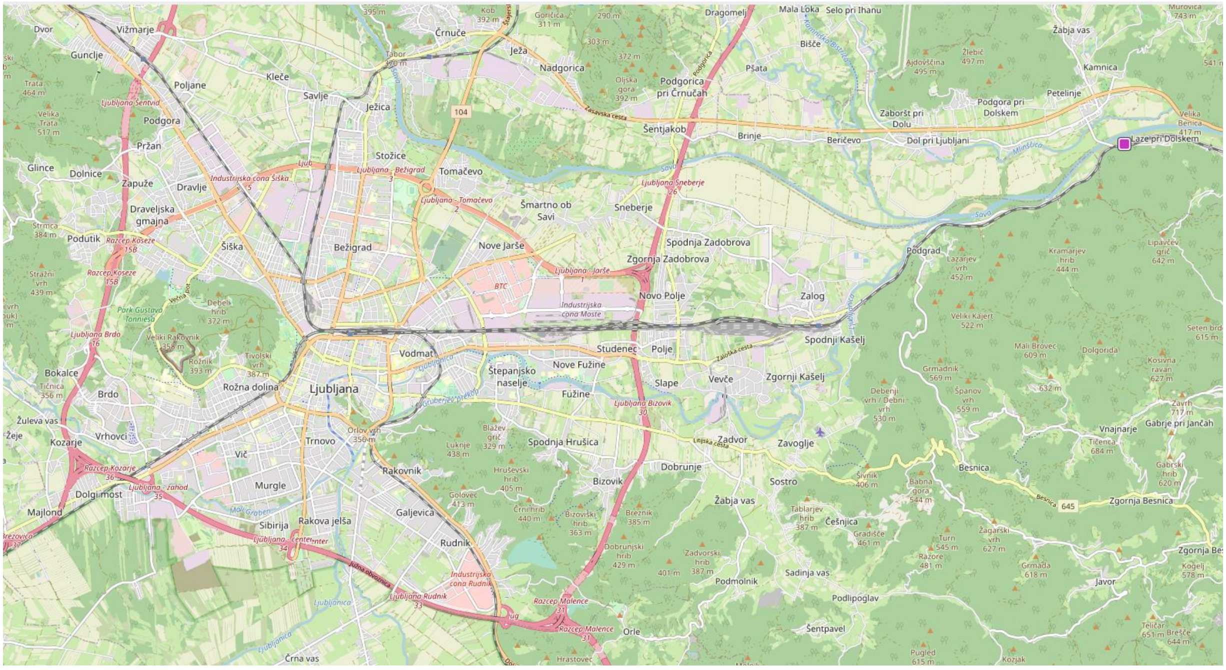

Figure 16. Water sampling location in the Ljubljana region

Figure 17. Water samples at the IOS

5.6.2 Drinking water

In Ljubljana drinking water is sampled regularly from locations which vary every year. A sample of tap water of 30-50 L is collected once a year usually from schools. In total, 15 samples are measured annually for gamma emitters H-3 and Sr-90 (by gamma spectrometry, radiochemical separation and LSC) in Slovenia. Between 120-240 samples are measured annually for gross alpha and gross beta activity (by total alpha and total beta counting). The sample is dried to a residue of 10-50 g and analysed in one of the authorised laboratories.

5.7 SOIL

In Ljubljana, the radioactive contamination deposited on the ground is checked by collecting and analysing soil samples from the same location twice a year.

Soil samples are collected by the contracted laboratory[10] with core at depths of 0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm and 40-50 cm. Each soil sample represents a total sampling area of 119 cm^2.

During the preparation process, stones are removed from the sample, the sample is grinded, air-dried and mixed, then sieved to 2 mm and homogenized. Sampling and preparation of soil samples are described in the laboratories written procedures.

The samples are analysed in both the IOS (country-wide) and the JSI (Ljubljana) laboratories. The radionuclides assessed in soil samples are natural and artificial gamma emitters and Sr-90.

5.8 TERRESTRIAL BIOTA

Radioactivity in terrestrial biota is not monitored in Ljubljana.

[10] JSI has collected soil samples in Ljubljana and IOS on two locations for the national programme (Kobarid and Murska Sobota).

5.9 FOOD

The food monitoring programme in Slovenia is performed under a program designed by the SRPA and performed by the authorised TSO's (IOS and JSI).

5.9.1 Milk

Radiological monitoring of milk provides information on the radionuclide content of milk produced in Slovenia. In Ljubljana milk is sampled daily from diaries, which in turn collect milk from a wider area. The methodology and the necessary quantities to be sampled are defined by the contractor. Currently, every day 0.15 L – 0.2 L of milk is taken and stored. A composite sample from 2 months is dried, ashed and measured. Altogether, 24 samples are collected in a year for determination of natural and artificial gamma emitters and Sr-90.

5.9.2 Mixed diet

Monitoring of mixed diet has been carried out in Slovenia since 2008. Samples of a person's daily diet are collected once a year, from Monday to Friday, from kindergartens in Ljubljana. The radionuclides assessed are natural (K-40) and artificial gamma emitters and Sr-90.

5.9.3 Foodstuffs

The programme in Ljubljana covers collection of various foodstuffs:

- vegetables: e.g. potatoes, lettuce, spinach, carrots, cabbage, beans, tomatoes
- fruit: e.g. apples, peaches, cherries, plums, pears, strawberries, cherries
- cereals, bread: e.g. wheat, corn, rye, barley, bread, white flour
- cheese, eggs, beef, pork, fish, poultry, honey, venison

Samples are collected by the SRPA once per year and sent to the authorised TSO for analyses.

24 samples (2-3 kg of every sample) per year are collected from various locations in Slovenia. The number of samples collected from Ljubljana region vary, in 2022 there were 6 samples taken in the Ljubljana region, locally grown and originating from other countries, available to the public in supermarkets. Assessed radionuclides are natural and artificial gamma emitters and Sr-90 in the most consumed foods grown and produced in Slovenia

5.9.4 Feeding stuff

Feeding stuff are sampled by the JSI and analysed in the JSI laboratories in Slovenia. Feeding stuffs collected include corn silage, hay, grass and compound feed. Altogether 10 samples per year (of 2-3 kg each) are collected in Slovenia. Of these, one sample (compound feed) was collected from Ljubljana region in 2022. In particular, as regards fresh grass at least 10 kg are collected and analysed once per year. Assessed radionuclides are natural and artificial gamma emitters and Sr-90.

5.10 EMERGENCY MONITORING

5.10.1 Introduction

The SNSA is responsible for preparing the emergency planning for Slovenia. The Civil Protection is responsible for implementing the countermeasures proposed by the SNSA.

There are two mobile monitoring units in Ljubljana, one operated by the IOS and one by the JSI ELME (Mobile Ecological Laboratory Unit).

5.10.2 IOS

The IOS mobile unit, shown in Figure 18, is equipped with a range of equipment including:

- Dose rate monitors
- Portable contamination detectors

- Two mobile gamma detectors with Pb shielding +copper and plastic
- computers and electronics + Wifi communication for the Canberra and Berthold + Mirrion;
- NaI spectrometer MIRION – one SPIRA-A CS for radionuclide identification
- NaI isotopes Identifinder
- Scales for heavy samples
- Handheld contamination equipment
- Hand-held Plastic scintillator, three by three inch, detector cylindrical with capability to detect natural background and hot spots, with Wi-Fi data transition capability.
- Air sampler installed in the mobile car with aerosol and charcoal filters
- Soil sampling equipment and other (auxiliary) equipment (portable dosimetric system for personal dosimetry, personal protective equipment and communication and meteorological equipment),
- 3 kW power generator (Honda Inverter EU30i).

At the IOS, the staff involved in the emergency monitoring are grouped in 3 groups of 4 persons each trained to work on the mobile monitoring. All teams participate regularly in exercises organized by the Krsko NPP and by other external organisations (IAEA, ...). The teams perform daily dose rate measurements. Three persons are specialised in gamma-ray spectrometry measurements.

The mobile gamma spectrometers are characterized, checked, and verified by the manufacturer company. The IOS has accredited standards from the Metrology Institute. Calibration is done every two years. The calibration of contamination and handheld dose rate monitors is performed every 2 years at the JSI. The required cooling time for the spectrometer is 4h.

The laboratory has participated in an Interlaboratory Comparison on in situ gamma spectrometry organised by NPL (UK) in summer 2021. It is further planned to have in-situ gamma spectrometry under ISO 17025 accreditation.

Calibration standards are available for soil, vegetation, sediments, and air filters.

Figure 18. IOS Environmental monitoring vehicle

5.10.3 JSI

The JSI – ELME (Ecological Laboratory with Mobile Unit), which is part of Slovenian Civil Protection Service and funded by ACPDR and NPP Krško, has a mobile radiological laboratory (Figure 19). The mobile laboratory is equipped with measurement equipment (various dose-rate and contamination (survey) meters/monitors, hand-held FieldSPEC for rapid nuclide identification, neutron monitor, portable HPGe gamma-ray spectrometers (in-situ gamma spectrometry), spectrometer, Hot spot locator), sampling equipment (portable air pumps with aerosol and charcoal filters, soil sampling equipment and other (auxiliary) equipment (portable dosimetric system for personal dosimetry, personal protective equipment and communication and meteorological equipment). The available measurement equipment is shown in Figure 20.

Figure 19. JSI-ELME mobile radiological laboratory

(a) **(b)**

(c)

Figure 20. Portable devices for (a) dose rate, (b) contamination and (c) gamma spectrometry measurements of the JSI-ELME Mobile radiological laboratory

The JSI-ELME Mobile radiological laboratory participates in the following trainings and exercises:

- Seminars organized by the ACPDR
- International CBRN workshops, seminars organized by IAEA, EU, NATO
- International Intercomparison of gamma-ray spectroscopy measurements (ALMERA)
- International intercomparison of dose rate measurements (Ronneburg)
- Exercises organized by IAEA and SNSA (Convex)

ELME's staff participates also in educational efforts targeting first responders (firefighters, rescue services, military, Civil Protection Services – ACPDR), including:

- Lectures and seminars on radiation protection
- Organization of intercomparison measurements for first responders
- Simulations of CBRN accidents in ICRP training center of: traffic accident, fire in an industrial facility, large spill.
- Interreg project ENRAS (ENsuring RAdiation Safety)

These trainings are very beneficial for ELME (cooperation with other first responders, communication, terminology, Incident command system, interplay of different aspects of accidents).

5.11 SPECIFIC MONITORING PROGRAMS

According to the Ionising Radiation Protection and Nuclear Safety Act (OJ RS, No. 76/17 and 26/19) and the Decree on national radon program regulation (OJ RS, No. 18/18, 86/18 and 152/20), the SRPA conducts systematic monitoring and measurement of radon in living areas and working environment. The measurements are performed by approved technical support organisations (TSOs). In the recent years, 480 measurements (track-etch detectors) in dwellings in radon prone areas were conducted annually. In kindergartens and schools, 325 of such measurements (track-etch detectors) are conducted annually. Additionally, 60 more complex measurements aimed at finding radon sources or establishing time profile of radon concentrations have been conducted each year. Based on these results, remediation measures are taken in kindergartens and schools, financed by the Slovenian government. In basement or ground floor workplaces in radon prone areas or at workplaces where higher radon concentrations can be expected (e.g. show caves, spas), the employers are obliged to provide measurements of radon concentrations. The SRPA maintains a national radon database. Each year, the TSOs prepare a report which is publicly available at the SRPA webpage[11]. The main findings of this report are included in the Annual Reports on Radiation and Nuclear Safety in the Republic of Slovenia.

In addition to this, there is a program of systematic inspection of NORM industries in Slovenia. Every year, five facilities where NORM are used or processed are inspected by the SNSA. The practice and the selection of facilities are based on the requirements of Art. 23 and Annex VI of the EU Basic Safety Standards Directive (2013/59/Euratom). Dose assessments are performed for each individual facility as well as for each industrial sector. This process can result in legal requirements or optimisation procedures for the facility.

[11] https://www.gov.si/en/state-authorities/bodies-within-ministries/slovenian-radiation-protection-administration/about-the-slovenian-radiation-protection-administration/

5.12 INFORMATION FOR THE GENERAL PUBLIC

The public in Slovenia is informed about environmental radioactivity in both normal conditions and emergency situations. Environmental monitoring data are provided on-line, in real time, in both normal and emergency situations on a specific website[12]. The operators of facilities discharging radioactivity in the environment, the nuclear regulatory body, the environmental protection authorities, the public health authorities, as well as the emergency response organisations are responsible for informing the public about the radioactivity levels in the environment. Data and detailed evaluation are published every year on the SNSA and the government website[13]. In addition, data are available, with a certain periodicity (generally, 1 year) on the other governmental websites as part of annual reports[14].

The information provided to the public include:

- The measured gamma dose (rate and integrated)
- The measured radioactivity levels in the air, in water, soil, vegetation, food and drinking water
- The radioactivity discharges in the atmosphere and in water
- The doses to the public, estimated based on the measured values, as well as details about the monitoring program and the interpretation of the measured values.

Additional studies in environmental monitoring have been developed and made available to the public via the government website.

In case of an abnormal event, information will be made available to the public on the same website of the Slovenian Government.

12 https://www.radioaktivnost.si

13 https://www.radioaktivnost.si/rvo_public/RVO/BasicInformation/Data.

14 https://podatki.gov.si/data/search?s=ursjv , https://www.gov.si/drzavni-organi/organi-v-sestavi/uprava-za-varstvo-pred-sevanji/o-upravi-republike-slovenije-za-varstvo-pred-sevanji/letna-porocila-o-obsevanosti-prebivalcev-slovenije/ and https://www.gov.si/drzavni-organi/organi-v-sestavi/uprava-za-jedrsko-varnost/

6 ANALYTICAL LABORATORIES

6.1 INSTITUTE FOR OCCUPATIONAL SAFETY

6.1.1 Introduction

The IOS has a main laboratory in Ljubljana. Overall, it employs some 100 staff, among them 13 (to increase to 15 from 1st September 2022) in the radiation protection unit laboratory, including 10 experts. The IOS Radiation Protection Unit laboratory is involved in routine and emergency monitoring of air (integrated gamma dose, aerosols, radon, atmospheric deposition), water (surface water, drinking water, sediment), soil (cultivated and uncultivated), vegetation (grain, grass, fruits and vegetables) and food (milk, meat, fish, mixed diet, etc.). The laboratory is authorised by SNSA for radiological monitoring of foodstuff and drinking water in both normal and emergency situations, as well as for emergency monitoring of the environment. It holds an ISO 17025 accreditation.

The laboratory also carries out measurements of radon as follows: long-term exposure to Rn by track etch detectors; Rn samplings using charcoal canisters and measurement by gamma spectrometry; Rn measurements using active measurement techniques. The focus is on measurements to Uranium mine tailings. All Rn measurements are accredited according to ISO 17025.

Overall, the IOS analytical laboratories analyse about 500 samples (all types) per year, including food samples. In emergency situations the analytical capacity of the laboratory can increase by 100 times depending on activity of the samples.

6.1.2 Sample preparation and counting

The laboratory has written procedures for sample identification and registration (procedure DP-LMSAR-01: Encoding system for gamma spectrometry and radiochemical measurements) as well as for sample preparation (procedure DP-LMSAR-03: Sample preparation of biological and environmental samples for gamma spectrometry and radiochemical measurements).

In the two sample preparation rooms the water evaporation is performed using an oven and an evaporator. Air glass fibre filters are cut in round shapes and put in cylindrical bakers.

Sample is received by the laboratory staff, who fill in the sample sheet. The sample is registered in the Sample Register Book (written form, PC form) after receiving it in the laboratory. The identification information includes sample code, type of sample, locality, name of the monitoring programme, quantity of the sample (mass/volume), name of the persons who sampled, accept, prepare, analyse the sample etc; the dates of the sampling, preparing of the sample, analyses etc..

Sample preparation is performed in accordance with the standard working procedures of the laboratory. Laboratory procedures of sample preparation include for example:

- soil grinding and severing;
- for water precipitates evaporation on at temperature <60^{o}C to avoid iodine escaping;
- for vegetables ashing in 400^{o}C, assuming iodine has decayed, to avoid Cs-137 escaping);
- homogenisation, milling;
- radionuclide separation for Sr analyses.

The samples are measured using the Canberra Gamma spectrometers or the Berthold proportional counter to assess the radioactivity content of gamma emitting radionuclides and/or Sr-89/90. The gamma spectrometry counting time is one to three days, while the counting time for Sr radionuclides is 2x1000 min. In an emergency situation the counting time is adjusted according to the sample activity.

6.1.3 Counting equipment

Table I presents the counting equipment available at the IOS laboratories. The minimum detection limits are set in national legislation.

Table I. IOS main laboratory measuring equipment

Measurement	Measurement device
Gamma spectroscopy (These systems are available for emergency monitoring too)	5 (4 plus 1 as backup) gamma-spectrometry systems with HPGe detectors, with relative efficiencies between 20 and 40 % and a measuring range of 40-1850 keV; Typical LLDs for measurements of Cs-137 are 1E-06 Bq/m^3 in air samples (atmospheric deposition and aerosols), 5E-03 Bq/kg in food samples, 4E-02 Bq/kg in soil and sediment samples
Gamma spectroscopy (portable)	Two portable gamma-spectrometry system Canberra Inspector 2000 for in-situ gamma spectrometry with a measuring range of 40-1850 keV and typical LLDs for measurement of Cs-137 of 1E-06 Bq/m^3 in air samples (atmospheric deposition and aerosols), 5E-03 Bq/kg in food samples, 4E-02 Bq/kg in soil and sediment samples
Measurements of Sr-90, Sr-89, I-131	Berthold LB770 10-channel low level planchette counter for beta measurements with typical LLDs for measurement of Sr-90 of 0.1 Bq/m^3 in soil and sediment samples, 1E-06 Bq/m^3 in air samples, 1E-04 Bq/kg in food samples and 5E-02 Bq/kg in milk samples; the typical LLD for measurement of Sr-89 in air samples is 1E-04 Bq/m^3, the LLD for I-131 is 0,005Bq/l.
Radon and radon progenies this equipment is also available for emergency monitoring	AlphaGuard (Saphymo GmbH, Germany) for direct measurements of radon concentrations and radon progenies concentrations in the air varying from 10 Bq/m^3 to 100 kBq/m^3 Electronic Radon Detector Rad7 (Durridge Co., USA) for direct measurements of radon concentrations and radon progenies concentrations in the air varying from 10 Bq/m^3 to 100 kBq/m^3 WLM 30 Working Level Monitor (EDA, Canada) for measurements of radon progenies concentrations in the air varying from 10 Bq/m^3 to 100 kBq/m^3 DOSEman device (SARAD GmbH, Germany) for measurements of radon progenies concentrations in the air varying from 10 Bq/m^3 to 100 kBq/m^3

Gamma background measurements are acquired every month over one weekend. Energy resolution checks are performed before each measurement using reference sources. The efficiency calibration is performed with gamma standard sources (Analytics) in the same matrix as the sample.

6.1.4 Data handling and reporting

IOS has no dedicated laboratory information management system. The measurement results are recorded, saved and backed up in the form of spectra and electronic database entries.

For samples measured by gamma spectrometry, calculation of results is performed using Canberra's GENIE 2k software. For Sr radioisotopes calculation, an Excel spreadsheet is used.

Data handling is performed using Excel spreadsheets. Measurement data and their evaluation are included in an electronic MSQL based database called MESAR (introduction of data to e-DB on weekly

basis). Reporting below MDA is done according to Commission Recommendation of 18 December 2003[15].

An overall report is extracted from the MESAR database for the SNSA. Frequency of reporting of environmental monitoring results is defined in contracts with the SNSA. Interim and annual reports are prepared.

In addition, all IOS measurements of the year are summarised in a report of the National Radioactivity Monitoring that is sent to the SRPA and to the National Library and is available to the public.

The SNSA system which handles off-line data, is the ROKO database which allows providers to submit data in a form that can be automatically assimilated in the database.

6.1.5 Accreditations and proficiency tests

The laboratory is accredited according to SIST ISO/EN 17025:2017 for all radioactivity measurement methods, including gamma spectrometry measurements, Sr-90 analyses, measurements of radon and radon daughter concentration (with charcoal detectors, active instruments, track-etch detectors). Written procedures are kept as hard copies in the laboratory's office and are also electronically available. Background measurements are performed regularly.

IOS's gamma spectrometry laboratory participates every year in 3-10 inter-comparisons organised by the IAEA, PTB Germany or NPL UK, for measurement of various samples including water, ash, air filter, NORM, and/or ashed milk.

6.2 JOŽEF STEFAN INSTITUTE

6.2.1 Introduction

The Jožef Stefan Institute (JSI) is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. JSI provide certified (accredited) analytical methods for determining the content of radionuclides in the environment. At the JSI there are two departments and two special institutional units related to the field of the radiation protection:

- Radiation Protection Unit (RPU) – SVPIS
- Department of Low and Medium Energy Physics (F2)
- Department of Environmental Sciences (O2)
- Milan Čopič Nuclear Training Centre (ICJT)

Departments F2 (ICMIS - Infrastructure Centre for Ionizing Radiation Measurements - Radioactivity Measurements-) and O2 (Radiochemistry) are mandated to carry out monitoring of radioactivity in the environment by Authorisation No 35400- 3/2019/12 of 14 January 2020 issued by SNSA. ICMIS is a group of laboratories within the Department F2 and O2. The basic program of work in ICMIS represents the research in atomic and nuclear physics, research in biological and geochemical cycles, radiochemistry and radioecology, and environmental protection. The contents of chemical elements and radioactive isotopes in the samples are determined using dedicated measurement analytical methods.

The Jožef Stefan Institute (JSI) fulfils many tasks, among others it is involved in the national monitoring programme for environmental radioactivity. This verification covered the ICMIS (in the department F2. Laboratories in the ICMIS at F2 are:

[15] Commission Recommendation 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 (notified under document number C(2003) 4832) OJ L 2, 6.1.2004, p. 36–46)

- NDS - Laboratory for Dosimetry Standards[16]
- LMR - Laboratory for Radioactivity Measurements[17]
- TLD - Laboratory for Thermoluminiscent Dosimetry[18]
- ELME - Ekological Laboratory with Mobile Unit[19]
- LSC - Laboratory for Liquid Scintillation Spectrometry[20]
- XRF - Laboratory for X-ray fluorescence spectrometry[21]

The team also visited the laboratory for radiochemistry of department O2 at the research reactor premises.

The Reactor Centre houses a research group for Radioecology and a research group for Radiochemistry that perform mostly scientific work. The laboratory has accredited methods for neutron activation analysis, Sr-90, H-3 and C-14.

The verification team concentrated on the work associated with the analysis of samples for SNSA within the environmental monitoring programme.

The ICMIS laboratories perform monitoring of air (gamma dose rate, integrated gamma dose, aerosols, atmospheric deposition), water (groundwater, surface water, drinking water, sediment, sea water), soil (cultivated and uncultivated), vegetation (grain, grass, fruits and vegetables) and food (milk, meat, fish, mixed diet, etc.). The ICMIS conducts sampling, sample preparation, analyses utilizing high resolution gamma spectrometry (all types of samples), LSC (H-3 (drinking water), C-14 (biological samples)), TLD dosimetry. It operates also a secondary standards laboratory (with Am-241, Cs-137, and Co-60 sources and X-rays) and a dosimetry laboratory and the mobile laboratory (ELME). The Department of Environmental sciences performs radiochemistry (H-3 (precipitation, air), C-14 (WMT), Sr-90 (all sample types)). These laboratories are involved in routine and emergency monitoring, are authorised by the SNSA and have methods accredited according to ISO 17025.

Two PhDs, one technician (radiochemical sample preparation), and a number of students (post-graduate studies) work in the Laboratory for Radioecology. Six PhD scientists, four MSc ones, two engineers and two technicians work in the ICMIS.

6.2.2 Sampling, sample preparation and counting

Samples are registered in paper and electronic forms. The data are stored in a relational database.

The water samples are of 45 L volume. A low temperature automatic liquid evaporating system is used for concentrating water samples (Figure 21).

In the ICMIS sample preparation rooms the following procedures are performed according to dedicated SOP documents: grinding, sieving, pressing, homogenisation, air-drying, evaporation, radiochemistry. All the samples are prepared in cylindrical geometries.

The samples are measured using the HPGe gamma spectrometers, LSC, or by using radiochemistry methods. Gamma spectrometry counting times vary from 20h to 40h. Alpha spectrometric analyses are performed for U-238, U-234, U-235, Ra-226, Th-230, Th-232, Pu-239/240, Am-241, Cm-244, Po-210, and other radiological relevant actinides.

[16] https://f2.ijs.si/en/laboratories/2020070315401451/nds--laboratory-for-dosimetry-standards-
[17] https://f2.ijs.si/en/laboratories/2020070315091296/lmr--laboratory-for-radioactivity-measurements
[18] https://f2.ijs.si/en/laboratories/2020070316073306/tld--laboratory-for-thermoluminescent-dosimetry
[19] https://f2.ijs.si/en/laboratories/2020070812324878/elme--ecological-laboratory-with-a-mobile-unit-
[20] https://f2.ijs.si/en/laboratories/2020070314151323/lsc-%E2%80%93-laboratory-for-liquid-scintillation-spectrometry
[21] https://f2.ijs.si/en/laboratories/2020070316341005/xrf--laboratory-for-xray-fluorescence-spectrometry

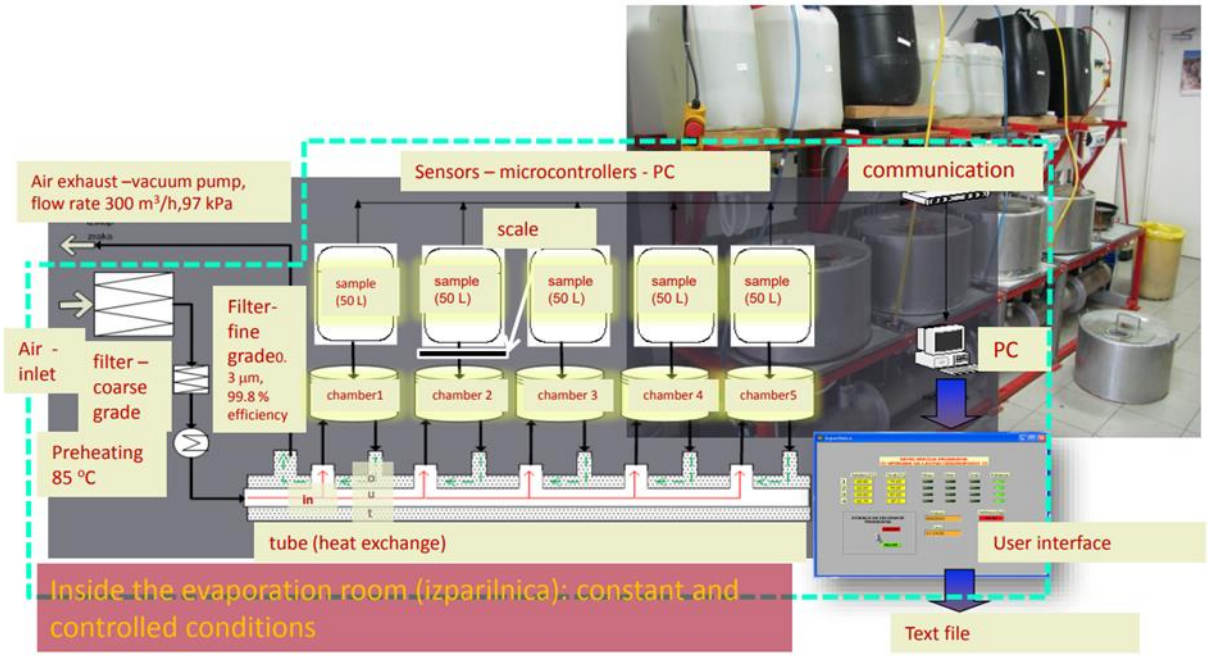

Figure 21. Sample preparation at JSI: Low temperature automatic liquid evaporation system

6.2.3 Counting equipment

The monitoring equipment of the JSI ICMIS laboratories is shown in Table II.

Table II. JSI main laboratory equipment

Measurement	Measurement device
Laboratory for Radioecology and Laboratory for Radiation Measuring Systems and Radioactivity Measurements (LMR), department F2	
Liquid scintillation counting	- 3 Liquid Scintillation Counter Quantulus PerkinElmer for H-3, C-14, gross alpha and gross beta activity determination, with a measuring range up to 2.3 MeV, and efficiency of 30% for H-3 determination, 10-60% for C-14 determination and 80-90% for gross alpha and gross beta activities; OBT and TFW
Gamma spectroscopy	- 9 stationary and 2 portable gamma spectrometry systems with n-type and p-type HPGe detectors for gamma spectrometry, with measuring range of 5 – 3000 keV, relative efficiencies between 24 % and 70 % and a minimum detectable range of emissions from the sample between 5E-03 and 5E+04 s-1
In situ gamma spectroscopy	
Laboratory for radiochemistry, Department of environmental sciences O2 at Research Reactor premises, JSI	
Alpha spectrometry	- Canberra Alpha Analyst (10 chambers, ca 450 mm2 PIPS detectors) for alpha-spectrometry, with a measuring range of 3 – 8 MeV, and a typical LLD of 0.0001 Bq;
Gross alpha and gross beta measurements	- Low-level beta proportional counter Eberline FHT 770T-6 for determination of Sr-90, with a typical LLD of 0.007 – 0.018 Bq;
Liquid scintillation counting	- 2 Liquid Scintillation Counters Packard TriCarb 170TR/SL and Quantulus PerkinElmer for determination of H-3 and C-14, with a measuring range of up to 2.3 MeV and typical LLDs of 0.015 Bq for H-3 and 0.019 Bq for C-14

6.2.4 Data handling and reporting

JSI has no dedicated laboratory information management system. The measurement results are recorded and saved in the form of spectra and reports. Printouts of the protocols are stored and archived. The measurement results are recorded on an Excel spreadsheet, where the measurement result is presented together with the measurement uncertainty or measurement MDA. Results below detection limits follow ISO 11929.

The results of the measurements are reported according to Rules JV10. The off-line data are transmitted to the ROKO database of the SNSA.

6.2.5 Accreditations and proficiency tests

All measurement methods are accredited under SIST EN 17025:2017; dedicated SOP documents exist.

Department F2 (Accreditation Certificates LP-022 and LK-017) carries out QA according to standard ISO/IEC 17025:2017. The accreditation covers High Resolution gamma spectrometry, LSC (H-3 (water, urine), C-14 (gross α/β), XRF spectrometry, TLD – analysis of irradiated food products (herbs etc), ELME, calibrations of dose rate and surface contaminations meters (SSDL).

Accreditation Certificate LP-090 (Department of Environmental Sciences O2) requires QA according to standard ISO/IEC 17025:2017. The accreditation covers: Sr-89/Sr-90, C-14 (alkaline liquids), H-3 (water, urine), Elemental composition of samples, Stable isotopes.

The JSI laboratory participates regularly in proficiency test and inter-comparison exercises provided by the IAEA, ALMERA, EC JRC, NPL, BfS.

7 VERIFICATIONS

7.1 INTRODUCTION

Verification activities were carried out in accordance with the agreed programme. 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 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 INSTITUTE FOR OCCUPATIONAL SAFETY LABORATORIES

7.2.1 General

The verification team verified the analytical process of the IOS analytical laboratory in Ljubljana[22]. The laboratory has good working facilities and adequate staff. There are in total 13 laboratory staff members. No equipment or staff shortages were reported to the verification team.

The radioanalytical laboratories of IOS are competent and reasonably equipped for radiochemical preparation and analyses of samples. The laboratories are authorised by the SNSA. The relevant measurement methods are ISO 17025 accredited while in-situ gamma spectrometry is in the process of accreditation.

The verification team noted that there are no arrangements for managing contaminated samples in an emergency situation, when the number of environmental samples may increase, and the samples may have considerably higher levels of activity than in a routine situation. The verification team was informed that emergency procedures already exist[23] and the documents will be revised.

> *The verification team recommends, that the IOS includes in the revised emergency procedures a plan for management of samples in an emergency, taking into account the increased number of incoming environmental samples with radioactive contamination.*

7.2.2 Sample preparation

The team visited the two sample preparation rooms (Figure 22). The team noted that the sample preparation rooms could benefit from better order.

The team was informed that the laboratory has written procedures for sample identification and registration, as well as for sample preparation. The team noticed that the sample labelling is written by hand (Figure 22a).

[22] Institute for Occupational Health (IOS), Pot k izviru 6, 1260 Ljubljana - Polje, Slovenia)

[23] ND-LMSAR-2.01 ''Navodila za delo v primeru radiološke intervencije'' and OB-LMSAR 2.02: ''Terenski zapisnik o radiološki intervenciji''

The verification team suggests introduction of printed bar-code labels for sample management.

(a)

(b)

Figure 22. Sample preparation (a) and evaporation rooms (b) at the IOS

7.2.3 Gamma spectroscopy

The verification team verified the gamma spectroscopy laboratory of the IOS. The laboratory is equipped with five Canberra HPGe detectors, in the range 20 to 40% relative efficiency and a measuring range of 40-1850 KeV. The detectors use Genie2000 software. One portable HPGe for in-situ measurements (Canberra Inspector 2000) was present in the counting room (Figure 23). One HPGe spectrometer is coupled with a digital electronics unit; the other four spectrometers operate with analogue electronics. Maintenance of the equipment is performed by the Canberra's service support located in Vienna.

Calibration is performed experimentally using gamma emitting standards (Analytics) in the same matrix (soil, vegetable, air filter or sediment) as the measured sample. Radionuclides contained in the calibration standards include Am-241, Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88 and Co-60. Radioactive standards for calibration are stored in separate locked room.

Detector system stability is controlled as follows: energy, resolution (FWHM) before each measurement, and efficiency every month; long-term trend graphs are maintained.

The verification team was informed that during calculation of activities efficiency transfer corrections are applied, however no coincidence summing corrections are considered. Uncertainties are calculated/estimated by the system.

The gamma background stability is check by a monthly background measurement.

No remarks.

Figure 23. Gamma spectrometry laboratory at the IOS

7.2.4 Alpha beta counting

The verification team visited the radiochemical laboratory where samples of fallout, river soil, food and milk are prepared by a dedicated technician for measurement of Sr-90 and Sr-89.

The team also visited the counting laboratory and verified the proportional counter used for measurements of I-131 and Sr-90 (Figure 24 left). Calibration of the counter is performed using reference sources of mixture of Am-241 and Sr-90. No total alpha-beta measurements are performed for the environmental monitoring programme. Additional backup counters are available (Figure 24 right).

No remarks.

Figure 24. IOS proportional counters

7.2.5 Sample storage

The verification team was informed that in the IOS laboratories samples are stored, in line with the laboratory's accreditation, for a period of 5 years after analysis. The 5 years storage applies also for the residuals of the samples. Some types of samples can be stored in racks (storage room in Figure 25) before the treatment.

No remarks.

Figure 25. Sample storage at the IOS

7.3 JOŽEF STEFAN INSTITUTE LABORATORIES

7.3.1 General

The verification team verified the radioactivity laboratories of the Józef Stefan Institute[24]. The JSI radioanalytical laboratories are competent and very well equipped for radiochemical preparation and analyses of the environmental samples. The laboratories are authorised by the SNSA; relevant measurement methods are ISO 17025:2017 accredited.

The Laboratory for Radioecology and the Laboratory for Radiation Measuring Systems and Radioactivity Measurements (LMR) in the Department of Low and medium energy physics F2 have 14 staff members.

No remarks.

7.3.2 Sample preparation

The team visited the sample preparation and evaporation rooms of the Józef Stefan Institute (Figure 26). The radiochemical laboratory is quite spacious and orderly.

No remarks.

[24] Jamova cesta 39, SI-1000 Ljubljana, Slovenia

Figure 26. Evaporation room at the JSI

7.3.3 Gamma spectroscopy

The verification team visited the gamma spectrometry laboratory of the JSI (Figure 27). The high-resolution gamma-ray spectrometry counting room is equipped with 9 HPGe detectors, which are used to determine γ-ray emitting radionuclides (Cs-137, Co-58, Co-60, Ag-110m, and others) in all types of environmental samples. The gamma energy range of the systems extends from 5 to 2700 keV. The sensitivity for Cs-137 is 0.1 µBq/m^3 (air) for high volume flow-rate aerosol pumps, 1.0 µBq/m^3 (air) for low volume flow-rate aerosol pumps and 0.1 Bq/m^3 for water samples. In addition, blanks (vial) are checked for radioactivity content.

The conditions in the counting room are controlled and kept stable. Pressure, temperature and humidity data data are used for Rn progeny activity concentration correction. A new ventilation system was recently installed. The activities of the natural radionuclides in various environmental samples are determined: U-238 from Th-234 and Pa-234m, Ra-228 from Ac-228, as well as Ra-226 from Pb-214 and Bi-214 (after correction for the exhalation of the Rn-222 from the sample).

Calibrations are performed with radioactivity standards in various cylindrical geometries (multi-radionuclide set). Corrections for density and composition of the sample are calculated using a mesh based on point sources and mathematical interpolation. True coincidence summing corrections are considered.

Stability of background is checked by background measurements performed every 30 days for a counting time of minimum 3 days.

Energy calibration checks are performed regularly. Quality checks of reported results are performed manually (e.g. in 2021 40 checks were performed in the samples analysed over the year).

No remarks.

Figure 27. Gamma ray spectrometry laboratory at JSI

7.3.4 Alpha counting

The verification team verified the alpha counting room. The laboratory is equipped with one Canberra Alpha Analyst with 10 chambers, ca 450 mm^2 PIPS detectors (Figure 28). The equipment is operational and used for alpha-spectrometry of environmental samples.

No remarks.

Figure 28. JSI Canberra Alpha Analyste

7.3.5 Liquid scintillation counting and tritium measurement

Department F2

The verification team verified the liquid scintillation counting laboratory (Figure 29) and the tritium enrichment system (Figure 30), part of the department F2 (ICMIS) of the JSI. The counting room is equipped with three Quantulus counters that are used to determine H-3 in water samples of various origin (groundwater, precipitation, surface, well-water) and C-14 in biological samples. The LSC laboratory of ICMIs is accredited for H-3 and C-14 measurements. The laboratory analyses half of the total number of samples per year, namely 200-300 samples for H-3 and 50-100 samples for C-14.

No remarks.

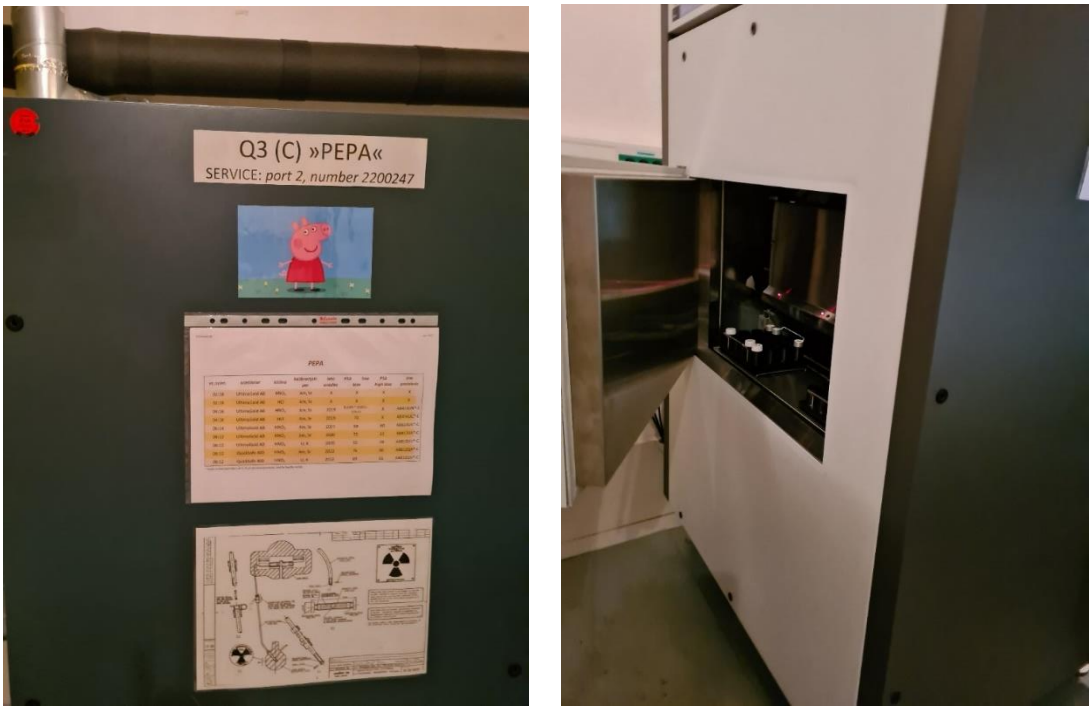

Figure 29. Liquid scintillation counters at the JSI Department F2

Figure 30. Tritium electrolytic enrichment system at the JSI

<u>Department O2</u>

The verification team visited also the liquid scintillation counting room (2 LSCs) and tritium measurement facilities at the radiochemistry laboratory, part of the department of Environmental sciences O2 of the JSI. The Department of Environmental sciences performs radiochemistry (H-3 (precipitation, air), C-14 (WMT), Sr-90 (all sample types)). The laboratory splits the samples for tritium measurements with the department F2, thus it analyses approximately half of the total number of samples, of 150 samples for H-3 and 200-300 samples for Sr-90 per year.

The samples (from precipitation stations, drinking water, surface water collected in the vicinity of NPP) with H-3 levels below than 5 Bq/L are enriched using the electrolytic system (Figure 31), while higher H-3 level samples are analysed directly by LSC (Figure 32).

The laboratory participates in 5-6 proficiency tests per year for measurement of H-3.

No remarks.

Figure 31. Tritium measurement system at the JSI Department O2

Figure 32. Liquid scintillation counter at the JSI Department O2

7.3.6 Sample storage

The verification team visited the storage room at the JSI and found it at very good quality (Figure 33). Samples are stored in good order for a period of 5 years for non-destructing analyses and for the residuals of the samples.

No remarks.

Figure 33. Sample storage at the JSI (ICMIS)

7.3.7 Individual dosimetry laboratory

The verification team visited the individual TLD-dosimetry laboratory (Figure 34). In the laboratory approximately 1000 measurements are preformed per month, resulting in approximately 10000 measurements per year.

No remarks.

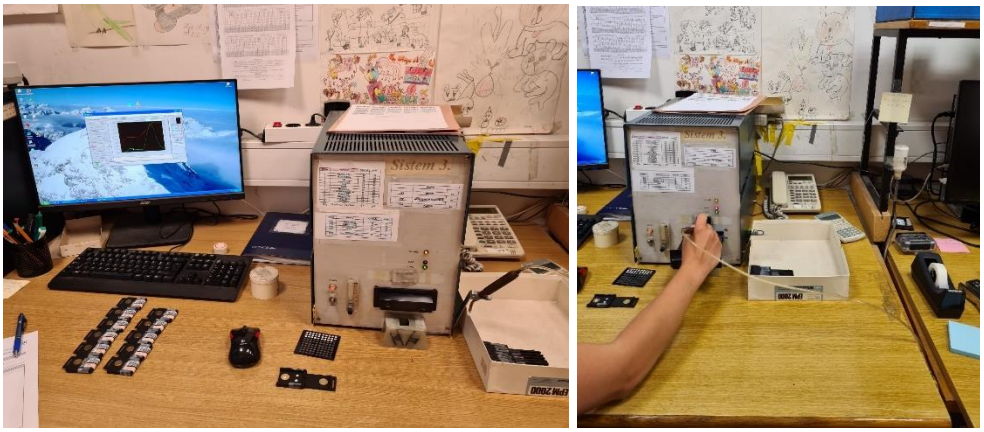

Figure 34. TLD-dosimetry laboratory at the JSI

7.4 ENVIRONMENTAL SAMPLING

7.4.1 Sampling programme

The verification team reviewed the environmental radioactivity monitoring programme in Ljubljana region including the sampling and measurement frequencies. The team noted that surface water is sampled and measured twice a year while mixed diet is sampled and measured once a year.

The verification team recommends increasing the frequency of sampling/measurements for surface water and mixed diet in line with the minimum quarterly recommended periodicity as per Commission Recommendation 2000/473/Euratom.

7.4.2 Air

Jožef Stefan Institute

The verification team verified the high-volume air sampler at the JSI garden in Ljubljana (Figure 35). The air sampler is operated by the JSI. The single-branch sampler uses a concertinaed fiberglass filter of an area of 0.87 m^2. At the air flowrate of 216 m^3/h the retention efficiency of the filter is 99.99 % for the particles larger than 0.3 µm. The air sampler is an in-house built device. It operates continuously 24 hours per day.

Figure 35. Single-branch high flow-rate air sampler at the JSI

The filters are collected monthly, folded, pressed, and packed into cylindrical plastic containers and measured by high resolution gamma-ray spectrometry. Subsequently, filters are destructively analysed, after radiochemical separation, to determine the content of Sr-90 in the sample using a gas flow proportional counter. The measurement results for the detected radionuclides are reported in terms of activity concentration (in Bq/m^3).

No remarks

Slovenian Nuclear Safety Administration

The verification team verified the online aerosol monitor at the research reactor premises (Figure 36). The on-line automatic aerosol monitors type AMS 02, manufactured by Bitt Technologies Austria is one of the three aerosol samplers received from Austria as a part of the bilateral cooperation agreements. The system is operated by the SNSA; maintenance is performed by the manufacturer every 3 months. The system can measure iodine; data is transmitted to the RVO system and to EURDEP.

No remarks

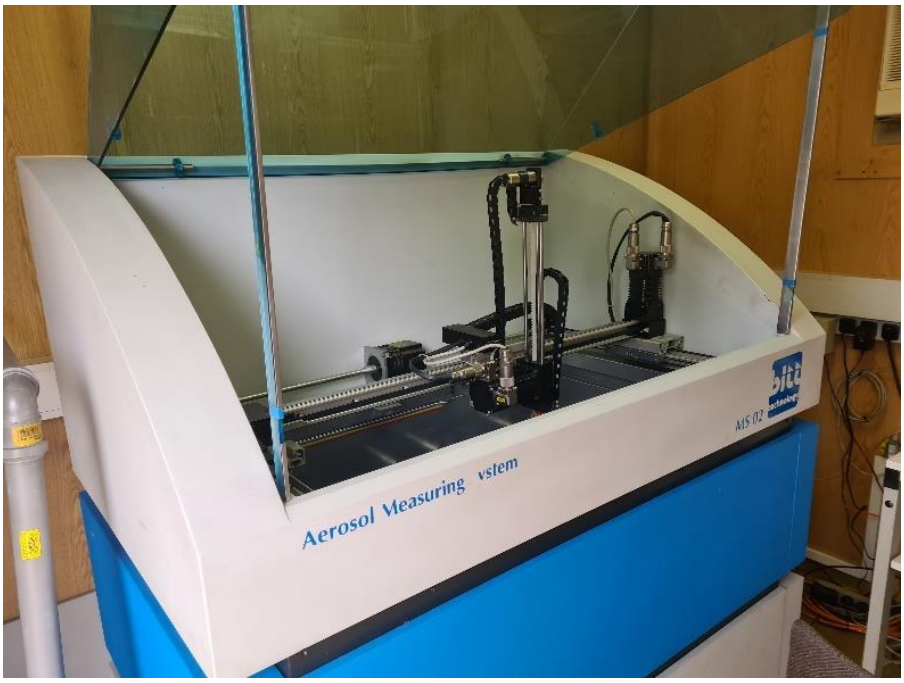

Figure 36. On-line aerosol monitor at the research reactor premises

7.4.3 Atmospheric deposition

Institute of Occupational Safety

The verification team verified the atmospheric deposition system located at the premises of the IOS (Figure 37). The system collects both dry and wet deposition using two rain collectors (metal buckets). The verification team was informed that samples are collected every month and measured by gamma ray spectrometry, as well as for Sr-90. A part of the sample is sent to JSI for H-3 measurement.

No remarks.

Figure 37. Dry and wet deposition collectors at the IOS

Jožef Stefan Institute

The verification team verified the atmospheric deposition sampling system located in the garden of the JSI (Figure 38). Precipitation is continuously sampled over a month in a 50 L replaceable plastic container. The dry deposition collector is an air dust collector (sticky plate) of an area of 0.3 m^3 with vaseline deposited on the plate (Figure 38).

Samples are collected monthly and sent to the laboratory for analyses. The collected water sample is concentrated in the laboratory by evaporation below 70°C. Since rainwater is known as a soft water with low or traces content of natural salts, before the evaporation process 10 g of oxalic and boric acid are added in order to simplify collection of residue by the evaporation process. Radionuclides that are assessed are natural and artificial gamma emitters, Sr-90, H-3.

No remarks.

Figure 38. Atmospheric dry and wet deposition collectors at the JSI

7.5 AUTOMATIC RADIATION DOSE RATE MONITORING

The verification team verified few stations part of the state-wide early warning network managed by the SNSA. The network comprises 56 gamma dose rate monitoring stations and sends data to EURDEP. The stations are calibrated every third year by the authorised calibration laboratory (NDS - Laboratory for Dosimetry Standards).

7.5.1 Slovenian Nuclear Safety Administration

The SNSA is in the process of upgrading the automatic dose rate monitoring system with new MIRA GDR probes. The replacement of the GDR probes with new MIRA stations has started. Priority is given to the problematic or non-working stations. The team witnessed the available monitors stored at the premises of SNSA awaiting installation within the upgrading programme (Figure 39). In Ljubljana, at the time of the verification, two out of three stations had been replaced, namely the ones at the JSI and at the research reactor premises. The replacement of the station at the meteorological institute needs to align with the latter institute's planning. A demonstration of the network data collection and display was shown to the verification team on the last day of verification, in the SNSA building.

The SNSA has 5 staff members managing the automatic dose rate network.

No remarks.

Figure 39. New MIRA GDRs stored at the SNSA premises

7.5.2 Jožef Stefan Institute

The verification team verified the automatic dose rate MIRA station located at the Józef Stefan Institute garden (Figure 40). This station is part of the new early warning network that is being installed in Slovenia.

No remarks.

Figure 40. MIRA station at the JSI garden

7.5.3 Research Reactor premises

The verification team verified the automatic dose rate MIRA station located at the Research Reactor premises (Figure 41).

During the visit at the Research Reactor premises, the verification team verified also the fixed spectrometric SARA station (Figure 42). The team was informed that this device is part of the research reactor monitoring programme.

No remarks.

Figure 41. MIRA station at the Research Reactor

Figure 42. Spectrometric station SARA at the Research Reactor premises

7.6 AMBIENT RADIATION DOSE

The verification team verified the TLDs are installed at the JSI meadow (Figure 43). The TLDs are placed in plastic housing (bottle) and located 1 m above ground. The TLDs are collected and read two times a year in the TLD laboratory of the JSI (ICMIS).

No remarks.

Figure 43. TLDs at the JSI garden

7.7 IOS MOBILE UNIT FOR RADIOACTIVITY MONITORING

The verification team verified the emergency monitoring vehicle at the IOS laboratory (Figure 44). The mobile laboratory is well equipped. The verification team verified the availability of the following mobile radiation monitoring equipment in the vehicle:

- Portable dose rate monitors (Figure 45)
- Portable contamination detectors Berthold (Figure 45)
- NaI spectrometer MIRION – one SPIRA-A CS (Figure 45)
- Portable NaI identifier SPIR-Ace (Figure 46)
- Portable high resolution HPGe based spectrometer (Figure 47)
- Plastic scintillator with Wi-Fi data transmission (Figure 45)
- Portable air sampler with iodine filter capabilities (Figure 48)
- Additional power supply
- Personal Protective Equipment

Figure 44. IOS Environmental monitoring vehicle

Figure 45. Handheld dose rate/contamination monitors and a plastic scintillator in the IOS environmental monitoring vehicle

Figure 46. Radio Isotope Identification Device SPIR-Ace in the IOS environmental monitoring vehicle

Figure 47. Mobile HPGe gamma spectrometer in the IOS environmental monitoring vehicle

Figure 48. Air sampler and filters in IOS Environmental monitoring vehicle

The verification team was informed by the JSI staff that they had received an IAEA EPREV mission three years earlier.

The 12 staff members trained for the mobile laboratory deployment in EPR are organised in 3 teams. Each team has one person specialised in gamma spectrometry measurements.

The verification team was informed that the mobile laboratory staff have provided trainings to civil protection personnel and to the fire fighters, although not on regular basis. The JSI has a refresher training module ready to be used in case of a radiological emergency.

No remarks.

8 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 useful.

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

(1) Overall, the environmental radioactivity monitoring programmes in Ljubljana 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 Ljubljana 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 Ljubljana are adequate. The Commission ascertained that these facilities are continuously available.

(4) A few recommendations and suggestions have been formulated. They concern establishing a procedure for management of samples during an emergency, increasing the frequency of sampling for specific media, and laboratory sample management. Notwithstanding these recommendations, the verified parts of the monitoring system for environmental radioactivity in Ljubljana are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

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

(6) The Commission services kindly request the Slovenian competent authorities to submit, before the end of 2024, a progress report on how the team's recommendations have been implemented, and 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.

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

ANNEX 1

VERIFICATION PROGRAMME

EURATOM ARTICLE 35 VERIFICATION SLOVENIA (LJUBLJANA)

6 - 7 JUNE 2022

Monday 6 June 2022

09.00 **Visit to the Institute for Occupational Health (IOS)**
(Address: Pot k izviru 6, 1260 Ljubljana - Polje, Slovenia)
- Mobile monitoring equipment overview
- Visit to the analytical laboratories

13.00 **Visit to the Jozef Stefan Institute (JSI) – Laboratory for Radioecology, Laboratory for Radiation Measuring Systems and Radioactivity Measurements (LMR)**
(Address: Jamova cesta 39, SI-1000 Ljubljana, Slovenia)
- Visit to the analytical laboratories
- Visit to on-site monitoring equipment

Tuesday 7 June 2022

09.00 **Meeting at SNSA**
Slovenian Nuclear Safety Administration (SNSA), Radiation Safety and Material Division, Monitoring Section
(Address: Litostrojska cesta 54, SI-1000 Ljubljana, Slovenia)
- Welcome
- European Commission Art. 35 verification programme introduction
- Discussion on the past verifications in Slovenia by the Commission
- Goals of the verification

11.00 **Overview of radioactivity monitoring arrangements in the Slovenia and in Ljubljana**
Slovenian Nuclear Safety Administration (SNSA), Radiation Safety and Material Division, Monitoring Section
(Address: Litostrojska cesta 54, SI-1000 Ljubljana, Slovenija)
- On-line radioactivity monitoring
- Off-line radioactivity monitoring
- Emergency radioactivity monitoring
- Public information arrangements

13.00 **Radiation warning systems and verification of selected monitoring facilities in Ljubljana and surroundings**
(Ljubljana Brinje, location of the Research Reactor)

16.00 **Open discussion and review of Slovenian data in the Art. 35 database**
(Address: Litostrojska cesta 54, SI-1000 Ljubljana, Slovenia)

Closing meeting