EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

Directorate H – Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

MONITORING OF ENVIRONMENTAL RADIOACTIVITY OF FORMER URANIUM MINING AND MILLING SITES AND NATIONAL MONITORING NETWORK FOR ENVIRONMENTAL RADIOACTIVITY

SLOVENIA

30 May to 03 June 2011

Reference: SI-11/02

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES	Installations for monitoring and controlling radioactive discharges and for the surveillance of the environment of former uranium mining and milling sites in Slovenia; monitoring network for environmental radioactivity in Slovenia
SITES	Ljubljana, Žirovski Vrh, Suha, Podroteja, Postojna, Sečovlje-Portorož, Koper, Dolenje, Bilje, Nova Gorica, Solkan, Bovec, Rateče, Rudno Polje, Lesce
DATE	30 May to 03 June 2011
REFERENCE	SI-11/02
Verification team	C. Gitzinger (team leader)
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DATE OF REPORT	2011-11-24

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ABBREVIATIONS

a.s.l.	above sea level
AMES	Automatic Measuring Systems for the Environment Ltd (Ljubljana)
BfS	*Bundesamt für Strahlenschutz* (German Federal Office for Radiation Protection)
BSS	Basic Safety Standards
cpm	counts per minute
DAC	Derived Air Concentration
DG ENER	Directorate General for Energy
DG TREN	(former) Directorate General for Energy & Transport
EARS	Environmental Agency of the Republic of Slovenia
EC	European Commission
EIMV/TPP	Milan Vidmar Electric Power Research Institute / Thermal Power Plant
EIB	European Investment Bank
EPROM	Erasable Programmable Read Only Memory
ERICo	Environmental Research & Industrial Cooperation Institute
EURDEP	European Radiological Data Exchange Platform
GM	Geiger-Müller (radiation detector)
GSM	Global System for Mobile communications
HPA	Health Protection Agency (UK)
HIRS	Health Inspectorate of the Republic of Slovenia
HPGe	High Purity Germanium (gamma radiation detector)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IOS	Institute of Occupational Safety, Ljubljana
IPA	Instrument Performance Assessment
IRMM	Institute for Reference Materials and Measurements (DG Joint Research Centre, Geel, BE)
ISDN	Integrated Services Digital Network
ISO	International Standardization Organization
ISOCS™	(Canberra) In Situ Object Counting System
JRC	Joint Research Centre (European Commission)
JSI	Jožef Stefan Institute (Ljubljana)
LEGe	Low Energy Germanium (gamma radiation detector)
LabSOCS™	(Canberra) Laboratory SOurceless Calibration Software

LMR	Laboratory for Radiation Measuring Systems and Radioactivity Measurements (at JSI)
LSC	Liquid Scintillation Counter (radiation detector)
MCA	Multichannel Analyser
MDA	Minimum Detectable Activity
MZO	*Mreža Zgodnjega Obveščanja* (Early Warning System)
NAA	Neutron Activation Analysis
NaI(Tl)	Sodium Iodide, Thallium activated (gamma radiation detector)
NPL	National Physics Laboratory (UK)
NPP	Nuclear power plant
NRPB	(former) National Radiological Protection Board (UK)
OJ	Official Journal
PIPS	Passivated Implanted Planar Silicon (alpha/beta radiation detector)
QA / QC	Quality Assurance / Quality Control
RBI	Ruđer Bošković Institute(Zagreb, Croatia)
RAM	Random Access Memory
ROKO	*Radioaktivnost v OKOlju* (Environmental Radioactivity data base)
RPNS	Radiation Protection and Nuclear Safety
SMS	Short Message Service
SNSA	Slovenian Nuclear Safety Administration
SRPA	Slovenian Radiation Protection Administration
TCP/IP	Transmission Control Protocol/Internet Protocol
TLD	Thermoluminiscent Dosimetry
UPS	Uninterruptible Power Supply
WHO	World Health Organisation

1. INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State establishes the 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 in order that it may verify their operation and efficiency.

For the EC, the Directorate-General for Energy (DG ENER), and in particular its Radiation Protection Unit (ENER D4), is responsible for undertaking these verifications.

The main purpose of verifications performed 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 into the environment by a site (and control thereof).
- Levels of environmental radioactivity at the site perimeter and in the marine (if applicable), terrestrial and aquatic environment around the site, for all relevant pathways.
- Levels of environmental radioactivity on the territory of the Member State.

The first EC verification of the national monitoring network for environmental radioactivity (laboratory based monitoring network) in Slovenia and radioactivity monitoring of the Krško NPP site was performed from 12 to 16 June 2006. From 30 May to 03 June 2011, a verification team from DG ENER (former DG TREN) visited the former uranium mining and milling site of Žirovski Vrh and different sites in Slovenia, which are part of the national monitoring system for environmental radioactivity. The laboratories of the Institute of Occupational Safety and the Jožef Stefan Institute, as far as they are involved in the uranium related monitoring tasks, were also included in the visit. The aim of the verification was to check the operation and efficiency of the facilities and associated analytical laboratories for continuous monitoring of the levels of radioactivity in air, water and soil in the vicinity of this site and some stations of the automatic monitoring network of dose rate levels on the territory of Slovenia.

During the verification activities addressing the monitoring of radioactive discharges from this former mining and milling site and the corresponding environmental radioactivity monitoring, the EC team was accompanied by representatives of the Slovenian competent authority, the Slovenian Nuclear Safety Administration (SNSA). The team also visited the laboratories and had meetings with representatives of national authorities the Slovenian Radiation Protection Administration, (SRPA, of the Ministry of Health) having competence in certain fields of radiation protection. An opening meeting and a closing meeting were held, with all parties involved during the visit, in the premises of the Slovenian Nuclear Safety Administration.

The present report contains the results of the verification team's review of relevant aspects of discharge control, radiological environmental surveillance and remediation activities put in place by the competent Slovenian authorities on and around the verified uranium mining and milling sites.

[1] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (OJ L-159 of 29/06/1996)

2. PREPARATION AND CONDUCT OF THE VERIFICATION

2.1. INTRODUCTION

The Commission's decision to request the execution of an Article 35 verification was notified to the Permanent Representation to the European Union of Slovenia by letter (ENER D.4/CG/cn Ares (2011) 84439) of 31 January 2011. Subsequently, practical arrangements for the implementation of the verification were made with SNSA, the competent authority, which provided preliminary information on the Slovenian legislation and its implementation with respect to radiation protection for uranium mining and milling sites as well as to the monitoring of environmental radioactivity on its territory.

The competent Slovenian authority SNSA efficiently acted as co-ordinator and thus ensured not only that the verification programme could be fully implemented, but also that all other actors involved in matters of radiation protection relevant to the mission were present and available during the week of the visit.

2.2. PREPARATORY DOCUMENTS

In order to facilitate the work of the verification team, information was supplied in advance by the SNSA in the form of detailed answers to a questionnaire from the Commission's services. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1. The information thus provided has been extensively used for drawing up the descriptive sections of this report.

2.3. PROGRAMME OF THE VISIT

A preliminary programme of verification activities under the terms of Art.35 of the Euratom Treaty was discussed and agreed upon with the Slovenian competent authorities.

The programme encompassed:

The verification of liquid and gaseous radioactive discharge control and of the environmental radioactivity monitoring programmes as carried out for the visited former uranium mining and milling site (sampling and monitoring systems, analytical methods, quality assurance, bookkeeping, reporting).

Parts of the national environmental radioactivity monitoring network (network of automatic stations for dose rate measurements) were also comprised in the verification as well as the concerned laboratories.

At the locations visited, the verification addressed technical aspects of monitoring and sampling activities, analytical methods used, quality assurance, data handling, archiving and reporting.

The verifications were carried out in accordance with the programme, an overview of which is attached as Appendix 2 to this report.

2.4. REPRESENTATIVES OF THE SLOVENIAN COMPETENT AUTHORITIES AND THE ASSOCIATED LABORATORIES

During the visit the following representatives of national authorities and other parties involved were met:

Slovenian Nuclear Safety Administration (SNSA), Železna cesta 16, Ljubljana:

Dr. Andrej Stritar	Director (univ. dipl. el.)
Maksimiljan Pečnik	Head of Division on Radiation Safety and Materia (univ. dipl. geol.)
Dr. Barbara Vokal Nemec	Coordinator, Head of Section of monitoring (univ. dipl. chem.)
Michel Cindro	Physicist (univ. dipl. phys.)
Dušan Peteh	Electronics engineer (univ. dipl. el.)

Slovenian Radiation Protection Administration (SRPA)

Dr. Nina Jug	Physicist (univ. dipl. phys.)

Jožef Stefan Institute, Jamova 39, Ljubljana

Dr. Borut Smodiš	Chemist (univ.dipl. chem.)
Dr. Benjamin Zorko	Physicist (univ. dipl. phys.)

Institute of Occupational Safety, Chengdujska cesta 25, Ljubljana

Dr. Gregor Omahen	Head of Centre for physical measurements (univ.dipl. phys.)
Peter Jovanovič	Physicist (eng. phys.)

Žirovski vrh Mine Ltd., Todraž 1, Gorenja vas

Peter Dolenc,	Director (univ. dipl. oec.)
Joze Rojc,	Head of Radiation Protection (univ.dipl. mining engineer)
Ivan Gantar,	Technologist

The verification team acknowledges the co-operation it received from all individuals mentioned and – without giving the individual names – of all the persons in charge of the monitoring stations we met.

3. BACKGROUND INFORMATION

3.1. INTRODUCTION

On the territory of Slovenia environmental radioactivity monitoring due to global contamination was established in 1961. Slovenia has a nuclear programme and therefore operational monitoring of radioactivity in the environment of nuclear installations is well justified.

Monitoring of radioactivity in the environment and of foodstuffs generally includes surveillance of artificial radiation and artificial radionuclides (with the exception in a case of monitoring of the uranium mining and milling site where natural radionuclides of the uranium decay series are analysed).

Exposure to natural radiation is controlled only if there is a reason to suspect that natural radionuclides may cause unusually high exposure to the public (e.g. indoor radon and natural radionuclides in drinking water).

The regular monitoring programme of environmental radioactivity covers the following segments of the biosphere: air, ground (soil, external radiation), surface waters and precipitation. Drinking water, foodstuffs and feeding stuffs are also monitored. Originally defined by the Ministry of Health it is still performed on the same basis. The programme is partly financed by the Slovenian Nuclear Safety Administration, and partly by the Slovenian Radiation Protection Administration and Food Safety Directorate.

The geographical distribution of sampling points for environmental monitoring fits the concept of integral monitoring networks of the former state of Yugoslavia.

3.2. RESPONSIBLE ORGANISATIONS

In the past the environmental radioactivity monitoring of global contamination exclusively belonged to the domain of health, namely to the Yugoslav Federal Ministry of Health (1961-1991) and then (1991-2002) to the Slovenian Ministry of Health.

According to the new act on radiation protection and nuclear safety, in force since 2002, the national environmental radioactivity monitoring of global contamination in Slovenia is the competence of three ministries, i.e. Environment, Health and Agriculture.

The principal bodies in the field of environmental radioactivity monitoring are the Slovenian Nuclear Safety Administration (SNSA) within the Ministry of the Environment and Spatial Planning and the Slovenian Radiation Protection Administration (SRPA) within the Ministry of Health. The Ministry of Agriculture, Forestry and Food (Directorate of Food Safety) is the competent authority for monitoring and control of fodder/feeding stuffs.

A complete overview is given in the organisational chart in Figure 1.

SNSA is a national authority and was founded in 1987 taking over the competences of the Energy Inspectorate with the main tasks on nuclear safety issues, including radiation protection in nuclear installations. With the new Act on Radiation Protection and Nuclear Safety (RPNS, 2002) SNSA took also the responsibilities for radiation protection in industry, research, education and state administration and took part in the national monitoring network of environmental radioactivity. For the control of environmental radioactivity in the surroundings of nuclear installations, including uranium mining and milling facilities, the competent authority is SNSA.

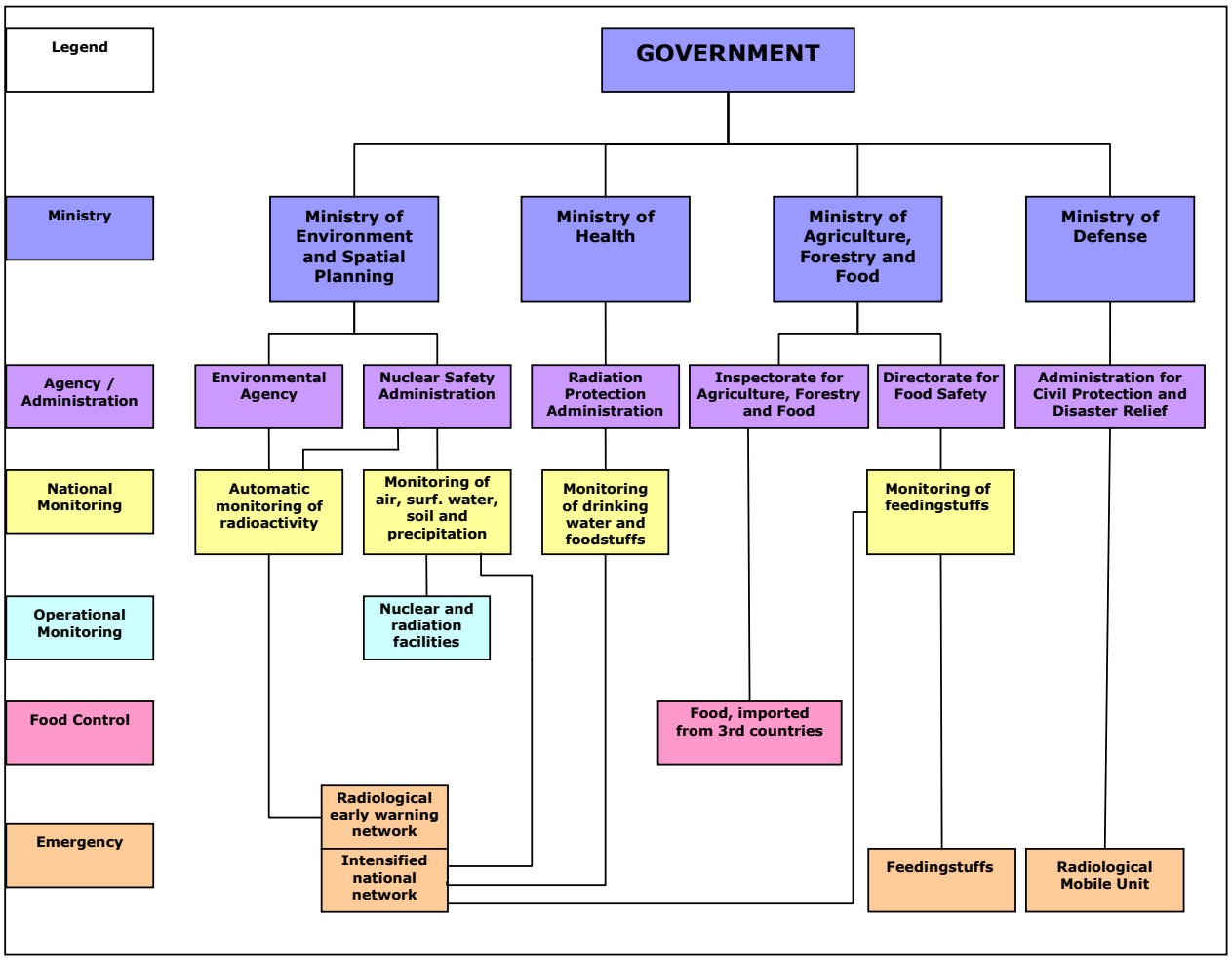


Figure 1: Competent bodies in the field of environmental radioactivity monitoring in Slovenia

The Slovenian Radiation Protection Administration (SRPA) is a national authority within the Ministry of Health. It was founded in 2003 and partly took over the competences of the Health Inspectorate of the Republic of Slovenia (HIRS) in the field of radiation protection.

SRPA performs regulatory, administrative, control and development tasks related to practices involving radiation and use of radiation sources in medicine and veterinary medicine; protection of people against ionising radiation; systematic survey of exposure of both living and working environments to natural radiation; monitoring of radioactive contamination of foodstuffs and drinking water; and auditing and authorisation of radiation protection experts.

In the past the national routine monitoring programme was approved by the Ministry of Health, from 2001 onward taking into account the Commission Recommendation 2000/473/Euratom of 8 June 2000 concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population. Since 2002 the national programme is jointly defined and financed by the Slovenian Nuclear Safety Administration, the Slovenian Radiation Protection Administration and by the Directorate of Food Safety of the Ministry of Agriculture, Forestry and Food.

The operational monitoring programme for nuclear installations is prepared by the operator and forms a constitutional part of the Safety report, which is entirely approved by the Slovenian Nuclear Safety Administration within the process of licensing. Monitoring of radioactive discharges is performed by

the operator itself while environmental monitoring (off-site) is performed exclusively by the approved technical support organisations with accredited laboratories. Radioactivity monitoring licence is granted to the technical support organisation by SNSA.

4. LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING IN SLOVENIA

4.1. LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

The most important legal texts dealing with environmental radioactivity monitoring in Slovenia are:

- Act on Ionising Radiation Protection and Nuclear Safety (RPNS), (OJ RS, No. 67/2002, 102//2004, 60/11)
  - Article 123 monitoring radioactivity in the environment
  - Article 124 operational monitoring of radioactivity
- Rules on radioactivity monitoring (OJ RS, No. 20/2007, 97//2009)
- RPNS Act, OJ RS, No. 67/2002, 102/2004, 60/11
  - Article 75 consent to construction licence
  - Article 77 a repository of mining and hydro-metallurgical tailings
  - Article 79 application for operation licence
  - Article 80 operation licence
  - Article 96 repositories of mining and hydro-metallurgical tailings
  - Article 99 national infrastructure facilities
  - Article 127 mitigation of consequences in the case of permanent exposure
- Decree on radiation practices (OJ RS, 48/2004, 9/06)
- Decree on dose limits, radioactive contamination and intervention levels (OJ RS 49/2004)
- Rules on radioactive waste and spent fuel management (OJ RS, 49/2006)

The responsibilities of the various actors in this domain are defined by:

- Articles 123 and 128 of RPNS Act, OJ. RS, No. 67/2002, 102/2004, 60/11

NORM mining activities are covered by:

- RPNS Act, OJ RS, No. 67/2002, 102/2004, 60/11
  - Article 45 systematic surveillance of living and working environment
  - Article 46 measures to reduce the exposure of workers and members of the public

Concerning the radiological surveillance of foodstuffs the following legislative acts apply:

- Act on Ionising Radiation Protection and Nuclear Safety (OJ RS, No.102/04 – official consolidated text), art. 123.
- Decree on dose limits, radioactive contamination and intervention levels (OJ RS, No. 49/2004), art. 29 and art. 38 (operative intervention levels for foodstuffs)
- 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)
- Regulations on drinking water (OJ RS, No. 19/2004, 35/2004, 26/2006), appendix I, part C
- 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)
- Rules on monitoring of radioactivity (OJ RS, No. 20/2007, 97//2009)

Legislation can be found on the internet site:
http://www.ursjv.gov.si/en/legislation_and_documents/legislation_in_force/

4.2. INTERNATIONAL LEGISLATIVE AND GUIDANCE DOCUMENTS

The main international legislative and guidance documents (IAEA, ICRP, EU) upon which the environmental radioactivity monitoring and the radiological surveillance of foodstuffs are based are:

Environmental radioactivity (for draft regulations):

- Environmental and Source Monitoring for Purposes of Radiation Protection Safety Standards Series No. RS-G-1.8
- 2004/2/Euratom Commission recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into environment from nuclear power reactors and reprocessing plants in normal operation
- 2000/473/Euratom Commission Recommendation 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.
- Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, Safety Reports Series No. 19, IAEA, Vienna, 2001
- Guidance on the realistic assessment of radiation doses to members of the public due to operation of nuclear installation under normal conditions, Recommendations of the group of experts set up under the terms of Article 31of the EURATOM Treaty, Radiation protection 127, 2002

Radiological surveillance of foodstuffs (for draft regulations):

- Council Directive 96/29/EURATOM laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation
- Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption
- 2000/473/Euratom Commission Recommendation 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
- 2001/928/Euratom Commission Recommendation of 20 December 2001 on the protection of the public against exposure to radon in drinking water supplies
- Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment, Radiation Protection 72, European Commission, EUR 15760 EN
- Guidance on the realistic assessment of radiation doses to member of the public due to the operation of nuclear installations under normal conditions Radiation Protection 129, European Commission, 2002
- IAEA TECDOC - 955 Generic assessment procedures for determining protective actions during a reactor accident, 1997
- IAEA Safety Reports Series No. 19 Generic Models for Use in Assessing the Impact of Discharge of Radioactive Substances to the Environment, 2001

5. THE URANIUM MINE ŽIROVSKI VRH AND ITS RADIOLOGICAL SURVEILLANCE PROGRAMME (DESCRIPTION AND VERIFICATION)

5.1. HISTORY OF URANIUM MINING AND MILLING IN SLOVENIA

The *Žirovski Vrh* uranium mine located about 40 km west of Ljubljana, was a small but technologically very advanced uranium mining and milling complex, however the period of uranium ore excavation and yellow cake production was rather short. The ore deposit in the area of the *Žirovski Vrh* ridge was the only one appropriate for exploitation in former Yugoslavia. Exploration works started in 1960. In the period of 1961–1990, 60 km of adits and 2.900 m of shafts were constructed. About 3,300.000°t of rock were excavated, which included 630.000 t of ore. In the ore processing plant, 610.000 t of uranium ore with an average concentration of 0.84 kg U_3O_8/t was processed and 452 t of yellow cake were produced. All U_3O_8 production was reserved for the former Yugoslavia (Krško Nuclear Power Plant) and no export to the Soviet Union took place.

Uranium ore exploration took place in the underground mine. Uranium was leached from crushed and ground ore in the ore processing plant. The average U_3O_8 ore grade in the process was 840 g/t. The 'limit cut mine waste' uranium ore was 250 g U_3O_8/t. The mill tailings were neutralised, dewatered to less than 25% moisture content by filters and deposed at the *Boršt* mill tailings site. The red mud that was a product of neutralisation process (with a relatively high concentration of Th-230) was deposited together with the mine waste at the *Jazbec* pile.

5.2. DESCRIPTION OF THE ŽIROVSKI VRH SITE

Appendix 3 in its second part shows the map of the *Žirovski Vrh* uranium mine with former and existent mine objects.

5.2.1. Underground mine

The underground mine is entirely situated above the Brebovščica valley through which a small stream flows. It has a length of 2000 m, a width of 200 m and a height of 200 m. The mine was operated from 1961 until July 1990, when a decree on temporary cessation of uranium ore exploration was accepted. Two years later a decree on the permanent cessation of uranium ore exploration was issued. Between 1992 and 1994 protective maintenance works took place and from 2002-2006 the mine pit was finally remediated. The mine entrances were backfilled, the mine pit closed and admittance into the mine is no longer possible. Mine water discharges are monitored regularly. In 2010, the total water flow was 750.000 m^3 (on average 24 l/s). The total annual precipitation in that year was 1944 mm.

5.2.2. Jazbec mine waste pile

The *Jazbec* mine waste pile is, situated above the ravine of the Jazbec stream. Its bottom point is situated at an altitude of 427 m and its top point at an altitude of 509 m. The disposal of mine waste started in 1982, and the pile was operated until July 1990. Also 48.000 t of "red mud" that was a product of the neutralisation process (with a relatively high concentration of Th-230) was deposited at the *Jazbec* mine waste pile. Later on (1998), some materials from decommissioning and decontamination of mine objects including wastes, which were previously temporarily disposed of at different locations and the debris of the demolished ore processing plant, were deposited here as well.

The final area of the Jazbec mine waste pile is 6.7 ha, the total mass of deposited materials is 1,910.425 t. Average U3O8 content is 69 g/t, total activity is 21.7 TBq.

5.2.3. The Boršt mill tailings

The *Boršt* mill tailings area has a surface area of about 4.2 ha and is situated on the slope of the Boršt hill. Its bottom point is at a height of 535 m, and the top point is at 565 m. About 610.000°t of mill waste were deposited there, together with 111.000°t mine waste and 9.500°t materials from decontamination procedures in the vicinity. The total deposited activity on the *Boršt* site is 48.8 TBq. The team was informed that 80% of the radon in the valley is of natural origin and only 20% stem from the *Boršt* mill tailings site.

5.3. REMEDIATION WORK AT THE ŽIROVSKI VRH SITES

The team was informed of the intensive remediation work that started in 1998 and was finished in 2010. Parts of the costs were financed by an EIB (European Investment Bank) loan. The *Wismut* company from Germany was a consultant to this work.

A five years transition period for all three mine objects is ongoing until 2014 with the goal to verify the effects of the implemented remediation measures and the still planned ones.

5.3.1. Underground mine

Already during the production period, adits were partially backfilled through boreholes from the surface. During remediation of the mine this work was ongoing and rooms in the underground-mine were partially backfilled with mine waste and concrete. Part of the excavated materials was also backfilled into the mine pit during 2005 and 2006.

The underground mine was permanently closed, discharge of the mine waters was arranged and the mine pit was isolated from the surface to prevent high radon emissions to the valley of the Brebovščica stream (period 2002-2006). By closing the mine, the inflow of additional underground-water to the area of the ore body was minimised.

A memorial plate marks the former main mine entrance (at the *Jazbec* site).

5.3.2. The ore processing plant

The ore processing plant was demolished, the site decontaminated and after remediation given to local society for unlimited use (period 1998-2000).

5.3.3. Jazbec mine waste pile

In the years 2006-2008 the *Jazbec* mine waste pile was partially reshaped and mine waste was compressed, its slopes were reduced, a cover of 1.95 m was constructed. The pile was finally remediated at the end of 2008. A concrete drainage tunnel was constructed at the bottom of the mine waste pile to drain seepage and ground-waters into the Brebovščica stream in the valley. In the year 2010, the amount of seepage waters from the drainage tunnel was 98.000 m^3 (average flow of 3.1 l/s).

The verification team was told that the site is stable and there are no problems.

Currently, the site is well covered with grass. The team witnessed a TLD control point of the Institute of Occupational Safety, Ljubljana.

5.3.4. The Boršt mill tailings

The *Boršt* mill tailings site was restored in the years 2007-2009. Contaminated parts of auxiliary objects and contaminated surfaces from other sites were removed and deposited at this mill tailing. The slopes were reduced, additional drainage was constructed to discharge seepage and surface precipitation waters from the tailings area and from the hinterland water flows.

At the end of 2009 the mill tailings were covered with 2.05 m soil and finally remediated in June 2010. In the year 2010 the amount of seepage waters from the mill tailings was 18.400 m^3 (average flow of 0.6 l/s).

The team was informed that in the year 1991, the base rock of the mill tailings started to slide slowly, typically some centimetres per year. These movements were brought to a standstill with the construction of a drainage tunnel under the mill tailings in 1994 and 1995. In 2008, the base rock movement started again at the site where the bigger part of the tailings is located. It is planned to implement technical measures in 2012 and 2013 to stabilise the base rock again.

The team witnessed that the surface of both above mentioned waste piles has been grassed; grass is cut regularly to avoid the growth of trees. Whilst receiving all these explanations, the team visited both, the *Jazbec* mine waste pile and the *Boršt* mill tailings site as well as the closed entrance of the underground mine. The team witnessed that the waste piles at the *Jazbec* and the *Boršt* sites are protected by a fence and the entrances are locked. On the fence there are radiation warning and 'stay out" signs. Public access is free to the areas outside the waste piles. At the *Boršt* site the team witnessed integrated GPS devices to control site movement and various concrete rain water drainage channels at the surface of the site to avoid rain water intrusion. The main drainage channel had fixed stones to reduce the flow rate. The team visited the central drainage tunnel. A dyke has been constructed outside the fence to protect the site from rainwater inflow

The vegetation cover of the *Boršt* mill tailings site appeared very dry at the time of the verification. The team was told that grass from this area is not used whereas that from the *Jazbec* site, which is of much better quality, is used for feeding purposes. Contamination checks are regularly performed for samples from both sites.

The team was told that at the site dry conditions lead to considerable wind erosion, whereas frequent heavy rainfalls (precipitation up to 14.4 mm/30 minutes) lead to erosion by water. The verification team was informed that re-shaping of the areas was based on extreme 100-year conditions with regard to meteorology and seismic activity. Since the conditions at the *Boršt* site could lead to the formation of 'liquid' material inside, the construction of a dam with a gravel road was decided.

> *The verification team encourages the implementation of the measures planned for 2012/2013.*

5.4. CONTROL OF DISCHARGES AND ENVIRONMENTAL RADIOACTIVITY MONITORING AT THE ŽIROVSKI VRH SITES

The monitoring programme of discharges from the mine facilities is determined by the annual Safety Reports of the *Jazbec* mine waste pile (the mine and the *Boršt* tailings pile are included into this report). These annual reports are addressed to SNSA. The content and frequency of the programme implementation has been adapted to the discharges after completion of restoration of both, the mine and the mine waste piles. For comparison purposes of the impact of the mine facilities on the environment, the permanent measurement and sampling points have been kept in use; i.e. in the valleys of the Brebovščica stream and of the Todraščica stream. If required, this regular monitoring programme is expanded, i.e. by radon measurements. Annual values of Rn-222 released into the

atmosphere and discharged activities of U-238, Ra-226 into the aquatic environment are comprised in the annual reports to the SNSA. The data are entered into the ROKO database at the SNSA.

Formerly, the monitoring programme of discharges was performed by the staff of the U-mine operator, for certain analyses also in close connections with the laboratories of the approved technical support organisations (JSI). Since 2005 the operator has no longer its own laboratory and all radiological measurements are subcontracted.

Air sampling (off-site)

At Gorenja Dobrava 27, a private property, the verification team witnessed an 'old' type aerosol sampler. Formerly, the device used cellulose filters; however due to problems with filter-blocking in winter by ice caused by fog from the nearby Brebovščica stream – the operator switched to glass fibre filters. An *Elster* gas counter is used for air flow measurement. The filters are analysed for U-238, Ra-226 and Pb-210. The sampling device is of the same type as the 'old' one at IOS (see chapter 7.2). Altogether there are five aerosol samplers installed in the area.

Radon

The team was told that Rn in the environment mainly comes from natural sources (the area being partly karstic); the former mining and milling activities only play a minor role. Different Rn exhalation limits have been introduced, for the *Jazbec* pile 0.1 and for the *Boršt* site 0.7 $Bq/m^2 \cdot s$. The reason is that the *Jazbec* pile is located below the level of the average inversion layer and thus radon in air is mostly dispersed at a slower rate, potentially leading to higher inhalation doses for the same soil exhalation rate.

An additional radon monitoring programme with track etch detectors was run in 2010 (at 32 points).

Several devices for automatic continuous measurements of radon decay products (TRACERLAB GmbH, Germany – donation of the Bavarian Ministry of Environment) are in operation; they were installed in the valley and at the U-mine sites two decades ago and are still maintained by the U-mine operator. These measurements are also the part of the regular environmental radioactivity monitoring programme.

Dose and dose rate measurements

As part of the national monitoring programme SNSA installed one ambient gamma dose rate station *AMES MFM 203* (with two GM tubes; energy response 60 keV to 1.3 MeV; measuring range 0.05 µSv/h to 1 Sv/h; battery backup for 2 days; the probes are mounted on two separate poles at about one metre above the ground at the Todraž site.

TLDs

The team witnessed a TLD control point of the Institute of Occupational Safety, Ljubljana, located approximately in the centre of the *Jazbec* site.

Waters and sediments

The only water treatment at the Žirovski Vrh uranium mine was related to suspended matter in the mine outflow water, no chemical treatment of discharge waters was applied. This has not been necessary since 2005.

At the *Boršt* site the verification team was shown a shaft that previously was used to take water samples on site. This sampling has been stopped because entering the shaft became too dangerous. With regard to ground water, piezometers (boreholes for detection of the water level) are used. Samples are taken with automatic devices and additionally once per week manually for control. With

regard to the monitoring of waters at the *Boršt* mill tailings site the verification team was told that there is risk of water inflow to the site body. An application to the government for funding additional boreholes has been made but not yet been decided.

At the *Boršt* site the team was shown the location 'SDB' (a small triangular weir) where for the effluent direct measurements of pH, conductivity and flow rate are performed and samples are taken.

Downhill from the *Boršt* site background and underground (= below pile) water is sampled at a weir near the exit of a tunnel, the entrance to which is locked (location 'MM Tunnel'; thin plate 90° triangular overflow construction).

Another outflow location ('MM BPG') is the West Boršt stream where a large weir (rectangular plus 90° triangular concrete and stainless steel) has been constructed. This is the measuring point for background water from the tunnel (due to rain) and seepage water (all *Boršt* waters). The location is fenced (stainless steel and aluminium profiles) and locked; several warning signs have been placed.

The team was told that there are no vandalism or theft problems in the area.

At Gorenja Dobrava surface water samples are taken from the Brebovščica stream. The team verified the automatic device (*Masterflex Composite Sampler*, *Horizon Ecology Co.*, Chicago, IL, USA; made in 1984). The device is installed in a locked cabinet and uses a peristaltic pump for taking small samples at intervals of 30 minutes, altogether 1.5 l per day. Apparently the device is very reliable, however the operator is now running out of spare parts (non-metric inch system for plastic hoses). Filtration of the samples is performed and monthly composite samples (25 l) are amassed. The team was told that in winter, when the stream is frozen, samples are taken manually (1/d). The samples are sent to the laboratory for measurement of uranium, radium, thorium, polonium-210, lead-210 and the determination of several chemical parameters.

Water sample pre-preparation (before sending to the laboratory) is by filtering and acidification for monthly and quarterly composite samples. There is none for grab samples.

Sediment samples are taken semi-annually at the same site.

Food, vegetation and soil

Milk is sampled once a year from the cows of the farm on the hill above the *Jazbec* site.

Soil and vegetation samples are taken annually at both sites, the *Jazbec* mine waste pile and the *Boršt* tailings pile.

> *The verification team encourages finding a solution to overcome the problems with unavailability of spare parts, e.g. by acquisition of new equipment if needed.*

5.4.1. Centre of long-term stewardship

The verification team was informed that a centre of long-term Stewardship at Todraž is being set-up to assure proper conditions for carrying out long term stewardship. Within the basic occupation (maintenance, monitoring, data storage) also information to the public will be accessible (current information on stewardship activities, on condition of the remediated piles and monitoring results) as well as possible education on mining and remediation (small indoor exhibition and outdoor technical park). There is awareness that long-term stewardship of the site will be needed. However, there are fears that due to a possible re-organization some of the knowledge may be lost and long-term stewardship may become more difficult to manage.

The verification team recommends doing all necessary in order to keep (local) site knowledge available and to set-up/maintain a firm system of long-term stewardship for the site.

6. NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING (DESCRIPTION AND VERIFICATION)

6.1. INTRODUCTION

The national environmental radioactivity monitoring programme comprises an automatic national monitoring network, and a laboratory based national monitoring system for air, soil, surface waters, precipitation, drinking water, foodstuffs and feeding stuffs.

The responsibilities at governmental level lie with the Ministries of the Environment, Health (drinking water and foodstuffs) and Agriculture, Forestry and Food (feeding stuffs).

The verification team noted that two governmental organisations are involved in national monitoring at the same level of competence, namely SNSA (with regard to general environmental media) and SRPA (with regard to drinking water and food). Collaboration between the two organisations seems to be satisfactory.

6.2. AUTOMATIC (ON-LINE) MONITORING SYSTEMS

6.2.1. General

The national automatic monitoring network for environmental radioactivity comprises 77 gamma dose-rate probes and three automatic aerosol monitoring stations (locations see Appendix 4).

Out of these 77 probes the Krško Nuclear Power Plant operates 13 probes distributed around the facility, mostly at distances of 2-5 km, within its own system.

An 'ecological system' of the Slovenian thermal power plants contains five gamma probes of the same type which are also maintained by the SNSA.

The system was upgraded by a recent PHARE Project and is managed in co-operation between the Slovenian Nuclear Safety Administration (SNSA) and the Environmental Agency of the Republic of Slovenia (EARS). The Milan Vidmar Electric Power Research Institute (EIMV) is associated on behalf of thermal power plant monitoring system. The locations of the gamma probes were selected as ones being already equipped with meteorological and hydrological instrumentation, respectively.

6.2.2. Ambient gamma dose rate

Ambient dose equivalent rate is measured continuously by an automatic network consisting of several sub-networks. The following types of probes are used:

- *AMES MFM 202/202A/203* (*AMES d.o.o.*, Slovenia); with two GM tubes (energy response 60 keV-1.3 MeV); measuring range 0.05 µSv/h to 1 Sv/h; battery backup for two days. *MFM 202* and *202A* are older versions of the electronics, *MFM 203* is a newer one; the probes can be connected to any of these. For the older version the probes are mounted on individual poles that are placed some 1 to 3 m apart, for the new version they are mounted on a single y-shaped holder, with a distance of some 25 cm. Calibration was formerly performed with a Co-60 source, since 2011 a Cs-137 source is used. The probes are operating continuously with 30 min measuring intervals or in preset-count mode (1400 counts). In case of external power failure, they have an internal

battery power supply for two days. In case of an alarm, they automatically switch to a five minute measuring interval.

- *ALNOR RD02-L* (*RADOS*, Finland); with two GM tubes (energy response 60 keV-3 MeV); measuring range 0.01 μSv/h to 10 Sv/h. Calibration is performed with a Co-60 source. The probes are operating continuously with 30 min measuring intervals. In case of external power failure, they have an internal battery power supply for two days. In case of an alarm, they automatically switch to a five minute measuring interval. Originally, the SNSA network consisted of eight such probes. At the time of the expansion in 2005, which was done with *AMES MFM* devices, it was decided to slowly phase them out so that all probes are of the same type. At the moment, there are still 2 *ALNOR* probes serving at the Reactor Centre Brinje and at the Krško NPP, as backup/insurance to the *AMES MFM* probes that are installed at the same locations. These two sites were not included in the current verification.

The verification team saw that all GM tubes are contamination protected by very thin aluminium foil hoods which can be replaced in case of necessity.

For the first set-up of the dose rate monitoring system placing the stations at sites of hydrological or meteorological stations had the advantage that all belonged to the same ministerial body. A further advantage was that the communication lines were already in place (at the time of installation mostly ISDN transmission, now slowly being replaced by direct internet access). At some hydrological station sites there are some disadvantages with regard to the representativeness of the site for the area. In general, from a radiological monitoring point of view, meteorological stations are better situated.

The team was informed that the upgrading of the detector locations with new probes is a gradual approach.

In case of a technical failure the faulty equipment will be replaced by SNSA staff with a spare unit (kept at SNSA), then handed over to the manufacturer (*AMES*) for repair. Subsequently the device is calibrated by JSI (calibrations are valid for three years; until recently they were based on Co-60, the new ones will be using a Cs-137 source). After calibration the device goes into storage at SNSA.

Telecommunication equipment is serviced by the Slovenian Telecom services.

The detector locations in Slovenia are shown in Appendix 4, Figure 1.

The verification team verified the ambient dose rate monitors located at the sites described below. With regard to using the detectors for both early warning and deposition estimation purposes all systems were operational. Some were not very well situated.

Suha-Škofja Loka – hydrological station

The dose rate monitoring station at Suha is placed at the hydrological station – *Hidrološka Postaja Suha - Sora* – that belongs to the Environmental Agency of the Republic of Slovenia (EARS; Ministry for the Environment and Spatial Planning), formerly to the Hydrometeorological Institute. At this location also several apparatus related to monitoring the Selška Sora River are installed; these are managed by other departments of EARS. The area is fenced with a locked gate (the same key goes for all stations), also the equipment hut door is locked. At this site there is no intruder alarm system (some other hydrological stations do have).

The device is of the type *AMES MFM 203*.

General placing: The station is located in a rather flat valley, however, close to the river bed and the slope of a hill.

Local situation: At a distance of about 3 m, there are trees and the equipment hut.

The two ambient gamma dose rate probes are installed on a single pole with a distance of approximately 30 cm between them, at about 1.2 metres above ground. The electronic equipment (data logger with display of counts, time, dose rate etc.; data transmission; UPS) is located in a small hut. At the time of the verification the display indicated a value of 87 nSv/h. Electric power is guaranteed by an internal battery allowing seven days collection time without power; in addition there is a 375 VA UPS (*MGE Elipse 375*).

At the same site there is also a precipitation sampler (25 cm diameter) that is taken care of by the hydrometrological unit of the Environment Agency; SNSA receives data and samples if needed.

The verification does not give rise to any short-term suggestions; however, finding a location better fit for placing the probe without obstacles is encouraged.

Podroteja – hydrological station

The dose rate monitoring station at Podroteja is placed at the hydrological station – *Hidrološka Postaja Podroteja - Idrijca* – that belongs to the Environmental Agency. At this location also several apparatus related to monitoring the Idrijca River are installed. The equipment hut door is locked.

The device is of the type *AMES MFM 203*.

General placing: The station is not ideally located in a very narrow valley, close to the river bed and the (steep) slopes.

Local situation: At a distance of a few metres there are trees, two houses and the hut for equipment.

The two ambient gamma dose rate probes are installed on a single pole with a distance of approximately 30 cm at about 2.5 metres above ground. The electronic equipment (data logger with display of counts, time, dose rate etc.; data transmission; UPS) is located in a small locked hut.

The verification team acknowledges the difficulty to find representative places in this area. However, it suggests replacing this location by a more suitable one in the vicinity and fixing the probes at the 'normal' height of 1 metre above the grassed ground as determined in the regulations.

Postojna – meteorological station

The dose rate monitoring station at Postojna is placed at the meteorological station – *Meteorološka Postaja Postojna* – (belonging to the Environmental Agency), on private property.

The device is of the type *AMES MFM 202*.

General site: Wide, very flat region, thus ideal conditions.

Local placing: The place is very well chosen, situated in a flat vegetable garden and lawn area with no trees close to it, the next (low) building being at a distance of ca. 20 m. The ambient gamma dose rate probes are installed on two separate poles with a distance of approximately 2.5 m, at about 1.2 m above ground. The electronic equipment is located in the basement of the nearby house.

At the same site there is also a precipitation sampler (25 cm diameter) and other equipment belonging to the Meteorological Office. The team witnessed also a TLD, mounted in a plastic flask that belongs to the system operated by JSI on behalf of the Slovenian Nuclear Safety Administration.

The verification does not give rise to any suggestions.

Koper – harbour

The dose rate monitoring station at Koper is located in the northern part of the harbour; the site is also used by the Meteorological Office, Environmental Agency.

The device is of the type *AMES MFM 203*.

General site: Wide, very flat region, near the Adriatic, thus excellent.

Local placing: The station is very well situated within the closed and protected area of the Koper harbour, on a flat lawn with short grass without trees nearby (some small trees about 5 m away). The probes are installed on a single pole with the 'standard' distance of some 30 cm, at about 1.4 meter above ground. The site comprises also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office as well as a TLD overseen by JSI. The electronic equipment is located in a small key box mounted near the probes. At the time of the verification the display indicated a value of 65 nSv/h. The team witnessed also a 375 VA UPS (*MGE Elipse 375*).

The verification does not give rise to any suggestions.

Portorož – airport at Sečovlje-Piran

The dose rate monitoring station at Portorož/Sečovlje/Piran is placed at the meteorological station – *Služba Letalske Meteorologije* – (belonging to the Environmental Agency) at the international Portorož airport ('aerodrome') site.

The device is of the type *AMES MFM 202*.

General site: Wide, very flat region, airfield, near the Adriatic, excellent conditions.

Local placing: The station is very well situated within the protected area of the aerodrome, in the fenced meteorological garden immediately besides the airfield on a flat lawn with short grass without trees nearby. The nearest building is at a distance of some 80 m. The probes are installed on two poles separated by some 3 m, at about 1 metre above ground. The site comprises also a precipitation sampler (25 cm diameter) and other – specific – equipment of the Airport Meteorological Office as well as a TLD changed every six months and overseen by JSI (code RP-41 Portorož). The electronic equipment is located in the Meteorological Office in the airport building.

The team was informed that the office is staffed from 06:00 to 23:00.

The verification does not give rise to any suggestions.

Dolenje – hydrological station

The dose rate monitoring station at Dolenje is placed at the hydrological station – *Hidrološka Postaja Dolenje - Vipava* – that belongs to the Environmental Agency. At this location several devices for monitoring the Vipava River are installed. The area is fenced with a locked gate; the equipment hut door is also locked.

The device is of the type *AMES MFM 203*.

General site: Wide, flat valley region (some 300 m to nearest hillside).

Local placing: The station is situated within the fenced area of the hydro-meteorological station, near a corn field and close to the river bank, about 1.5 m from the hut housing the data transmission equipment. The probes are installed on a single pole with the 'standard' distance of some 30 cm, at about 1 metre above ground. The site comprises also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office.

The verification does not give rise to any suggestions.

Bilje – meteorological station

The dose rate monitoring station at Bilje is placed at the meteorological station – *Meteorološka Postaja Bilje* – (belonging to the Environmental Agency) near an orchard and fruit market "*Sadjarski center Bilje*".

The device is of the type *AMES MFM 202*.

General site: In the centre of a wide, very flat valley.

Local placing: The station is very well situated within the meteorological garden, the fruit trees (the closest in some 10 m distance) being kept low. The nearest building is at a distance of some 100 m. The probes are installed on two poles separated by some 2 m, at about 1.2 m above ground. The site comprises also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office as well as a TLD overseen by JSI (code RP 38 Nova Gorica (!)). The electronic equipment is located in the Meteorological Office in the administration building.

The gate is generally locked, however, during day time, it is left open for easier access to read the meteorological equipment. The team was informed that the office is staffed by two professional meteorologists.

The verification does not give rise to any suggestions.

Nova Gorica – air quality monitoring station

The dose rate monitoring station at Nova Gorica is placed at the Air Quality Monitoring Station (belonging to the Environmental Agency that at this location operates several air monitoring devices) near the town centre of Nova Gorica, close to a commercial area. The container housing the data handling, communication and power supply equipment is locked. It is surrounded by a circular brick wall with a locked gate, which, as it does not touch the ground for the most part offers the possibility to pass under (thus, there are many signs of vandalism).

The device is of the type *AMES MFM 203*.

General site: Wide, soft hills. The station is situated on a hill, overlooking the town.

Local placing: The detector probes are fixed to the roof of the container (with a view to avoid damage by vandalism), on a metal beam, with approximately 25 cm distance between the two probes, about 3 metres above ground, overlooking the narrow inner yard between the outer wall and the container.

The verification team acknowledges the difficulty to find representative places in this area. However, it suggests replacing this location by a more suitable one in the vicinity. The height of the probe should be in conformity with the rules.

Solkan – hydrological station

The dose rate monitoring station at Solkan is placed at the hydrological station northeast of the town – *Hidrološka Postaja Solkan - Soča* – that belongs to the Environmental Agency. At this location several devices for monitoring the Soča River are installed. The site is located within the maintenance area of a hydro-electric power plant, the dam being some 500 m upstream. The whole area is fenced and the gate is guarded; the equipment hut door is locked.

The device is of the type *AMES MFM 203*.

General placing: The station is located in a quite narrow valley, close to the river bed.

Local situation: At a distance of a few metres there are high trees; the probes are mounted very close to the roof of the hut housing the technical equipment.

The two ambient gamma dose rate probes are installed on the side wall of the equipment hut on a single pole with a distance of approximately 30 cm, some 30 cm above the roof of the hut, at about 2.5 metres above ground. The electronic equipment (data logger with display of counts, time, dose rate etc.; data transmission) is located in a small locked hut. There is no UPS installed, obviously power is secured by the power plant electrical system.

The verification team acknowledges the difficulty to find representative places in this area. However, it suggests replacing this location by a more suitable one in the vicinity. The height of the probe should be in conformity with the rules.

Bovec – air field

The dose rate monitoring station at Bovec is placed at the meteorological station – *Meteorološka Postaja Bovec* – (belonging to the Environmental Agency of Slovenia) at the Bovec air field ('air theatre') site.

The device is of the type *AMES MFM 202*.

General site: Very wide, flat valley, airfields, very well suited.

Local placing: The station is very well situated in the fenced meteorological garden immediately beside the airfield without obstacles in the neighbourhood. The probes are installed on two poles separated by some 2.5 m, at about 1 metre above ground. The access gate to the meteorological garden is locked as is also the door of the equipment hut. The site comprises also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office.

The verification team witnessed the change of the probes that had been necessary and the installation of a new EPROM in the measuring system by SNSA staff.

The verification does not give rise to any suggestions.

Rateče

The dose rate monitoring station at Rateče is placed at the meteorological station – *Meteorološka Postaja Rateče* – (belonging to the Environmental Agency of Slovenia), on private property.

The device is of the type *AMES MFM 202A*. The team was informed that this was the first version of this type (with cover hood and power supply built in).

General site: Relatively wide valley.

Local placing: The place is situated in a garden and lawn area; fruit trees are some 10 m away, the next building being at a distance of ca. 15 m. The probes are installed on two separate poles with a distance of approximately 1.8 m, at about 1.1 m above ground. The electronic equipment is located in the house.

At the same site there is also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office. The team witnessed also a TLD that belongs to the system operated by JSI on behalf of the Slovenian Nuclear Safety Administration (code RP-33 Rateče).

The verification does not give rise to any suggestions.

Rudno Polje – military premises

The dose rate monitoring station is in a barracks area of the Slovenian Army at Rudno Polje.. The area is not fenced in.

The device is of the type *AMES MFM 203*.

General site: Mountainous region (Triglav national park area), however relatively wide valley.

Local placing: The station is situated on a lawn area beside the road; spruce trees are some 20 m away, the next building being at a distance of ca. 30 m. The probes are installed on one pole with a distance of approximately 30 cm, at about 1.3 m above ground. The electronic equipment including a 450 VA USB device *MGE Elipse ASR450* is located in an electronics cabinet nearby.

At the same site there is also a precipitation sampler (25 cm diameter) and other equipment of the Meteorological Office.

The verification does not give rise to any suggestions.

Lesce– airport

The dose rate monitoring station at Lesce is placed at the meteorological station – *Meteorološka Postaja Lesce* – (belonging to the Environmental Agency of Slovenia) at the Lesce-Bled airport site.

The device is of the type *AMES MFM 202A* (the old version with cover).

General site: Very wide, flat valley, airfield, very well suited.

Local placing: The station is very well situated in the fenced meteorological garden on a slight hill near the air field, on a lawn without obstacles in the neighbourhood. The probes are installed on two poles separated by some 2.5 m, at about 1 metre above ground. The access gate to the meteorological garden is locked as is also the door of the equipment hut. The site comprises also a precipitation sampler (30 cm diameter) and other equipment of the Meteorological Office.

The verification team witnessed the change of the probes that had been necessary and the installation of a new EPROM in the measuring system by SNSA staff. The new detector probes showed a calibration mark dated 13.11.2010.

The verification does not give rise to any suggestions.

6.2.3. Network data centres

All data including those from telemetric networks, in particular for ambient dose rate monitoring, are managed by the MZO system and database (*Mreža zgodnjega obveščanja* – Early Warning System). Probes from around the Krško NPP (13 units) have a separate alarm system. The raw data are transmitted automatically at 30 minute intervals via ISDN or Ethernet to the Environment Agency and to SNSA for archiving in "raw format" in three databases in three different servers (back-up). One of these servers is for public access.

The system is run on several independent industrial standard personal computers for enhanced reliability. One subsystem consists of two database servers running at the Slovenian Nuclear Safety Administration (SNSA) in Ljubljana, the other consists of two communication and two database servers at the Environmental Agency of the Republic of Slovenia (EARS), also in Ljubljana. The EARS central unit polls the measuring sites and stores data locally. Data are analysed and prepared for expert and public use and archived. The default communication interval is 30 min. In some stations gamma dose rate measurements are checked every five minutes. In case of exceeding the alarm values, the communication interval for all other stations is changed to five minutes for the duration that alarm values are detected at at least one station. Quality assurance is performed by the main data collection centre at the EARS. Schematics for the telemetric early warning system are presented in figure 2.

Periodically, the duty officer receives a "status" report for all stations. SNSA is authorised for international data exchange (e.g. data transmission to the European EURDEP system every ½ hour) and bilateral data exchange (with Austria, Croatia and Hungary in the EURDEP-Format).

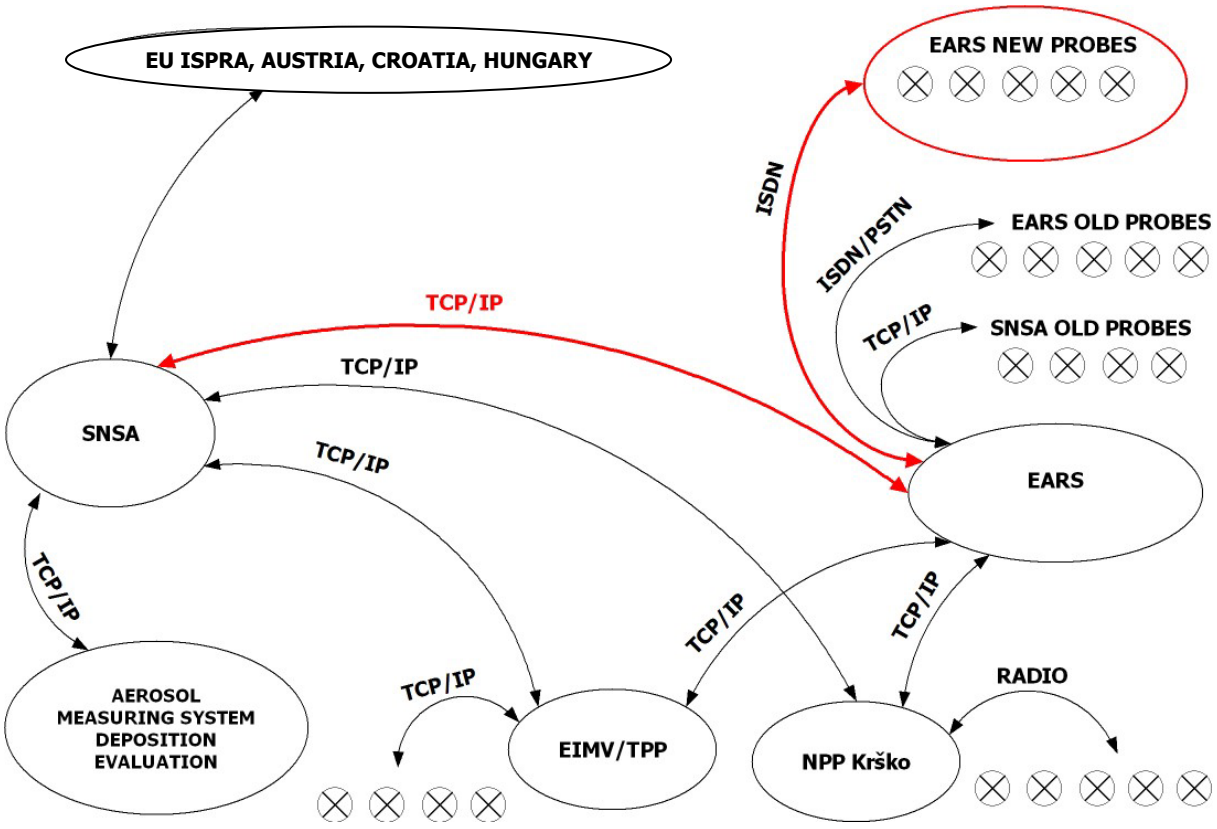


Figure 2: Data transmission pathways in the Slovenian early warning systems

The ROKO database (*Radioaktivnost v OKOlju*, Environmental Radioactivity) contains various categories of data (mostly off-line measurements performed in the scope of national and operational

monitoring), including the data from the former uranium mining site at Žirovski Vrh (each data set is characterized by location, isotope, date). Reports from the analysing laboratories arrive also in electronic form. Quality assurance is performed by the SNSA. An annual report is issued every 1st of July. Public access to these data is freely available (links on site, bulletins, pamphlets), but is not specifically promoted.

6.2.4. Alarm procedures

In case of elevated measurement values there are three warning levels:

I. After detecting a value above a pre-set level of 250 nSv/h, a gamma dose-rate station sends a warning message to the central server. The duty officer is notified and has to immediately check the data.

II. At a level of 300 nSv/h in at least three measuring locations the heads of the emergency expert teams at the SNSA are notified. They check the validity of data, discuss the situation and assemble at the headquarters.

III. At an alarm level of 500 nSv/h (or if more stations indicate high levels), the full emergency expert teams are notified and come together at the headquarters to start with their emergency work.

In case of an alarm the communication interval for all stations is changed to five minutes.

Alarm messages are stored on the main server and distributed through an internet service to GSM phones and local area computer networks to the on call duty specialists on a 24h basis. Measurement integration time and interval lengths for data sampling are separately adjustable for each station. Radiological data measured in the environment are used for modelling of dispersion of the radioactivity using appropriate software.

The team was given a demonstration of the software for the data presentation and analysis incl. monthly automatic reporting. The demonstration also covered data for milk, including historic data that had been manually typed in. Krško NPP related data are automatically inserted in the system.

The team was also informed that every month a report is generated automatically, including the registration of all meteorological data.

The verification does not give rise to any suggestions.

6.2.5. Air radioactivity

Automatic air radioactivity monitoring stations are situated at Brinje, Krško NPP and Drnovo and are of the type *Bitt AMS-02*, with alpha and beta measurement on aerosol filters using a PIPS detector. Drnovo station has an electrically cooled high resolution HPGe gamma spectrometry system for gamma nuclide specific analysis of the aerosol filters. Brinje and Krško NPP stations have a low resolution gamma spectroscopy system for measuring the filters. All stations also have low resolution gamma spectrometry on special filters for elemental iodine and on activated charcoal for organic iodine using NaI(Tl) detectors with automatic weekly calibration. The devices at Brinje and Krško NPP were provided by IAEA through a technical cooperation project and the other one was provided to the SNSA by the Republic of Austria. All have an official verification by the Austrian national metrological institute. Data transmission to the centre at SNSA is via computer lines. A UPS guarantees operation for one hour after a power failure (including the air pump).

The system at Drnovo also includes a gamma dose rate monitor (not included in the automatic ambient dose rate network) and a small meteorological measurement unit (temperature probes at two heights,

wind direction, wind speed and precipitation). According to the bilateral agreement the data from all three stations are automatically transmitted to the Radiation Protection Unit of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management in Vienna as well.

6.3. LABORATORY BASED (OFF-LINE) MONITORING SYSTEMS

The laboratory based monitoring system in Slovenia was covered during the verification in 2006 and was not part of the present verification.

The responsible organisations (SNSA for environmental media and the Ministry of Health for drinking water and foodstuffs and the Ministry of Agriculture, Forestry and Food for feeding stuffs) outsource environmental sampling and analysis to contractors having an ISO 17025 accreditation. Biannual calls for tender are published and appropriate organisations are selected for the various tasks. Maps in Appendix 5 show the locations of the sampling points for various media that are collected within the Slovenian laboratory based network for environmental radioactivity.

7. LABORATORIES INVOLVED IN URANIUM RELATED MONITORING

7.1. INTRODUCTION

According to the regulations SNSA approves the laboratories of the technical support organisations (TSO) that fulfil the provisions of radioactivity monitoring. Two laboratories of the Jožef Stefan Institute were approved (department of low and medium energy physics and department of environmental science) and one at the Institute of Occupational Safety (Centre for physical measurements). Both institutes are involved in the control of discharges and in the environmental monitoring programme for the Žirovski Vrh uranium mine. The analytical laboratory of the Environmental Research & Industrial Cooperation Institute (ERICo, Velenje) was approved for uranium determination in water.

Besides these programmes carried out by TSOs the uranium mine company performs also the extended control programme of the operation and efficiency of the remediated sites. It comprises measurements defined in the Safety report on remediation; e.g. in 2010: tests on radon exhalation from the cover of the repositories; gamma spectrometric analysis of the soil covers of these repositories, gamma dose rate, Rn concentration in air; inspections after work; and in 2011: gamma dose rate, exhalation, radon and radon decay products in air, radionuclides in seepage and underground water and in fodder. One of the reasons for this extended monitoring programme is informing the population and assuring it of the low risks involved.

The uranium mine company uses a tendering process for contracting monitoring and analysis tasks. The contracts are generally signed for duration of one year. Currently these labs are IOS, JSI, and to lesser extent also ERICo; (Velenje, SI). The ERICo laboratory was not included in the verification visit. For environmental media the contract may include sampling (including design, set-up and servicing of any sampling devices), sample transport, sample preparation, measurement and data reporting. Overall reporting on the results of environmental monitoring including evaluation is also outsourced. The reporting is from the measuring laboratories to the mine operator and from this to SNSA; currently the radiological impact evaluation task is handled by IOS.

7.2. INSTITUTE OF OCCUPATIONAL SAFETY (IOS) – LJUBLJANA

The Institute of Occupational Safety is a private company and deals with all kinds of occupational safety. Overall it employs some 88 staff, among them twelve in the radiation protection unit, including six experts. More staff could be available for the unit from other areas of the IOS and trained for radiological purposes if needed.

Since the last verification visit in 2006, the laboratory has got accreditation for Sr-90 analyses, gamma dose rate measurements, environmental dosimetry, and measurements of radon and its short-lived decay products. Gamma spectrometry is already accredited since 2003.

The laboratory has been involved with measurements from the uranium mine since 1985 and in addition to the "official" environmental monitoring programme has also carried out test measurements of the covering materials used in the remediation process (extended operators programme).

The laboratory carries out measurements on solid and atmospheric parameters: long-term exposure to Rn by track etch detectors; semi-annual Rn samplings using charcoal canisters (2 day sampling periods) with measurement by gamma spectrometry; annual dose rate measurements (TLD) at three locations. Air filters (5 sampling points) are sampled by the mine operator (quarterly) and are sent to IOS for analysis. These samples are also analysed for their U-238, Ra-226 and Pb-210 content as part of the regular environmental monitoring programme for the former uranium mine.

The verification team was informed that until 2010 the laboratory used 'Karlsruhe' devices for Rn analysis by track etch detectors; now an accredited Swedish firm (*gammaDATA*) has been contracted for this task. The track etch films (in plastic foil) are sent to the firm in Sweden by *DHL*; the results come after 1-2 weeks.

Measurement data and their evaluation are included in an overall report combining the results of all parties involved and compiled by an independent expert. They are reported to the mine operator who then sends the report to the regulatory authorities, i.e. to SNSA and SRPA.

IOS every year participates in radon charcoal inter-comparisons organised by BfS in Germany or HPA (formerly NRPB) in the UK. For the measurements of radon concentration by charcoal method is accredited according to ISO 17025. The same is true for the measurements of radon and radon daughter concentration. Currently, for the track etch method, there is no participation in such exercises by IOS because *gammaDATA* has ISO 17025 accreditation for this work.

All procedures are kept as hard copies in the labs' office and all are also available on the IT network (access based on staff function).

The team visited the sample preparation room where water evaporation is performed using a microwave oven.

The team witnessed that the unit operates five HPGe detectors of different suppliers in the range 20 to 40% relative efficiency plus a portable system (*Canberra Inspector 2000*).

Calibration of radon measurement devices is now performed every three years by BfS Berlin, using standard gamma spectrometric methods (there is no specific calibration e.g. with U standards). *US-Analytics* standards are used for inter-comparisons. For gamma spectrum analysis the lab operates *Canberra Genie*. In situ calibration with *Canberra ISOCS™* and laboratory sample calibration with *Canberra LabSOCS™* is available.

The participation in radon campaigns in areas with high radon risk is based on an annual tendering process (SRPA). For direct radon measurements an *AlphaGuard* (*Genitron*, now *Saphymo GmbH*, Germany) and an *Electronic Radon Detector Rad7* (*Durridge Co.*, USA) are available. With regard to

radon progeny measurements the laboratory has a *WLM 30 Working Level Monitor* (*EDA*, Canada), which is seen as 'the best device but old'. For the new *DOSEman* device (*SARAD GmbH*, Germany) an increase of the RAM and the battery is planned with a view to increase the operational life.

Currently IOS participates in international inter-comparison exercises. Till 2003 biannual inter-comparisons were organised between Slovenian laboratories performing radon and radon decay products' concentration measurements by the SNSA within the premises of the Žirovski Vrh uranium mine company.

Air samplers

Outside the building, in a vast meadow, the verification team was shown two air samplers.

The 'old' air sampler, using a gas counter for air flow measurement is no longer operational . A similar one still works in the area of the uranium mining site.

The 'new' air sampler has a flow capacity of 34 000 m^3/month. The device uses glass fibre filters (20 x 20 cm) and charcoal cartridges. The team was informed that its routine operation was stopped three years ago because IOS lost the contract to perform these analyses; they are now performed by JSI. Since the device is still functional, it was 'reanimated' during the Fukushima accident and some samples were taken at that time. In air masses arriving from Japan I-131, Cs-137 and Cs-134 could be detected.

In connection with the Fukushima accident also grass and soil (top layer) samples were analysed; in situ measurements were carried out as well. All these measurements only showed results below the limit of detection. Iodine-131 could be detected in fallout samples but not in milk samples.

The verification does not give rise to any suggestions.

7.3. JOŽEF STEFAN INSTITUTE (JSI) – REACTOR CENTRE, PODGORICA/BRINJE - LJUBLJANA

The Jožef Stefan Institute (JSI) fulfils many tasks, among others it is involved in the national monitoring programme for environmental radioactivity. Its Laboratory for Radiation Measuring Systems and Radioactivity Measurements (LMR) performing this work was visited in 2006 and was not covered in this verification.

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.

The centre also houses a research group for Radioecology, led by Prof. Dr. Borut Smodiš and a research group for Radiochemistry, led by Prof. Dr. Vekoslava Stibilj that perform mostly scientific work and less so radiological monitoring tasks. The laboratory has accreditation for Sr-90 and neutron activation analysis. Other units at the reactor centre have ISO 17025 accreditation, thus many commonly used infrastructural tasks use accredited methods.

The verification team was informed that the reactor may be shut down in 2016.

The verification team concentrated on the work associated with the analysis of samples connected to former uranium mining.

The team was told that the institute perceives the uranium mine as a "natural" laboratory and performs the analyses also for reasons of scientific research. Further to winning the annual call for tender, JSI currently works on the aquatic environment (including sediments) of the uranium mine. Samples are collected daily by the uranium mine staff and composite samples come to the laboratory once per month.

Sediment samples are collected using special equipment (bottle with holes), replaced/changed every three months.

The laboratory has SNSA approval for analysis of natural radionuclides for the operational monitoring programme for the uranium mine without accreditation due to high costs and because the number of samples is very low. The team was told that an advantage of this is also easier methodology development and adjustment.

In 2011 the laboratory also performed some studies in the area of food analysis, using alpha spectrometry.

Laboratory for Radioecology staffing is by two PhDs (one senior, who works on procedure development and previously had worked at IRMM Geel; one new); a technician performs radiochemical sample preparation. In addition students (after receiving their bachelor degree at the university) can be employed for post-graduate studies.

Sample registration for the uranium mine samples is performed in the same way as for the accredited work areas. The only difference is that for the department dealing with uranium mine samples this is done on paper and not in electronic form. The verification team was shown examples of sample sheets describing the kind of analyses demanded etc..

The laboratory performs uranium determinations by neutron activation analysis (NAA). This is a very expensive methodology and will only be feasible as long as the research reactor operates. Uranium analyses are performed mostly within scientific studies (e.g. transfer factors) and only to a smaller extent for radiological monitoring purposes. The main reason for using NAA is that extremely low limits of detection can be achieved. However, this seems unnecessary for routine monitoring tasks.

The team was told that samples irradiated in the reactor for short times are received in the laboratory via pneumatic delivery tubes; those for long irradiation times arrive in a hot cell. In the hot cell activated samples before further preparation steps 'cool down' until sample radiation is below a certain dose rate limit (such checks are performed by staff from the Radiation Protection Unit).

The team witnessed that the radiochemical laboratory was quite spacious and very orderly.

The procedures are in place (as if there was accreditation).

Procedural tests are regularly performed (e.g. of homogeneity of the precipitate by autoradiography).

Alpha spectrometric analyses (Ra-226, Th-230 and Po-210) are performed in this laboratory using a *Canberra Alpha Analyst* (10 chambers, ca 450 mm^2 PiPS detectors) and a low noise vacuum pump *TRIVAC E2*). All alpha spectra are kept on the original PC.

For radium determinations the laboratory uses Ba-133 as chemical yield tracer.

Measurement of activated samples by gamma spectrometry is performed on the sample to be analysed and on a 'standard' with known natural uranium content that was irradiated together with the sample. Comparison of the activation products' peak information allows quantification of the uranium content in the sample. For this method 'standard' calibration methods (e.g. by using a multi-radionuclide source) do not have to be applied.

Generally, for gamma spectrometry a well type detector and a LEGe detector (for Ba-133 determinations) are available. The laboratory is equipped with *Canberra* and *Ortec* detectors and NIM devices and an *Ortec DSPEC plus* digital gamma spectrometry computer interface. Spectrum analysis is done with *Canberra Genie 2000* software.

For Ba-133 determinations the calibrations are performed with Ba-133 standards (geometry: liquid deposited by microprecipitation on filters attached to planchettes).

The germanium detectors are filled weekly with LN_2 which is supplied by *Messer-Griesheim.*

The team traced a uranium sample of river water from Gorenja Dobrava taken in May 2009, by comparison with the value in the SNSA database (access via internet). The hand written log book included the calculation steps used and seemed unclear to the team. The team noted some confusion about relating measurement data to the sample. The archived spectrum could be retrieved and finally all values were found to be in full agreement.

The laboratory participates regularly in inter-comparison exercises with NPL, BfS, IAEA and EC.

An annual report is produced for the uranium mine operator in cooperation with IOS. This report includes also dose calculation. Until 1996 the main responsibility for the production of this report was with one institution, now the responsibility for this task is split into three parts (air, water, and dose assessment, the latter done by IOS with whom JSI has good co-operation).

A common data base exists (based on EXCEL files). These files are shared between the institutes. The electronic format of these reports has been defined by SNSA.

> *The verification suggests implementing a method that avoids manual inputs and calculations as much as possible, by e.g. designing an Excel structure with all calculation parts for sample analysis (that are not integrated in a measuring device), results, and if deemed useful for result presentation.*

8. CONCLUSIONS

All verification activities that had been planned were completed successfully. In this regard, the information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, was useful.

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

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil with regard to the surveillance of the Slovenian territory are adequate. The Commission could verify the operation and efficiency of these facilities.

(2) A few recommendations and suggestions are formulated, mainly in relation to general quality assurance and control. These aim at improving some aspects of the environmental surveillance. They do not detract from the general conclusion that the Slovenian national monitoring system of environmental radioactivity – including operational monitoring of the former Uranium mining and milling sites – is in conformity with the provisions laid down in Article 35 of the Euratom Treaty.

(3) The present Technical Report is enclosed with the Main Conclusions document and is addressed to the Slovenian competent authorities through the Slovenian Permanent Representative to the European Union.

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

APPENDIX 1

REFERENCES AND DOCUMENTATION

- Verification activities under the terms of Article 35 of the EURATOM Treaty: filled-in information questionnaire; SNSA, Ljubljana, 2011
- Various Power Point Presentations
- Various location tables

APPENDIX 2

VERIFICATION PROGRAMME

Sunday 29/5/2011

EC team travels to Ljubljana

Monday 30/5

1. 09:00 – 11:00: Opening meeting with presentations (Ljubljana, Slovenian Nuclear Safety Authority)
2. 11:00 – 12:00: Verification at national data centre (Ljubljana, Slovenian Nuclear Safety Authority)
3. 14:00 – 16:00: Visit of IOS laboratory (Ljubljana, only related to analysis of U, Ra, Rn)

Tuesday 31/5

4. 09:00 – 09:30: Verification activities at locations of the national monitoring system for environmental radioactivity in SW Slovenia: Suha-Skofja Loka
5. 10:00 – 14:30 Verification at former uranium mining and milling site: Žirovsky Vrh
6. 15:00 – 17:30: Verification activities at locations of the national monitoring system for environmental radioactivity in SW Slovenia (cont'd): Podroteja, Postojna, Koper

Wednesday 1/6

7. 09:00 – 17:00: Verification activities at locations of the national monitoring system for environmental radioactivity in SW Slovenia (cont'd): Sečovlje-Piran, Dolenje, Bilje, Nova Gorica, Solkan, Bovec, Kranjska Gora-Rateče
8. Travel to Bled

Thursday 2/6

9. 09:00 – 16:30: Verification activities at locations of the national monitoring system for environmental radioactivity in SW Slovenia (cont'd): Rudno Polje, Lesce-Radovljica; JSI laboratory at Ljubljana-Podgorica
10. 17:00 – 18:30: Closing meeting (Ljubljana, Slovenian Nuclear Safety Authority)

Friday 3/6

Return of EC team to Luxembourg

APPENDIX 3

MONITORING OF ENVIRONMENTAL RADIOACTIVITY AT FORMER URANIUM MINING AND MILLING SITES

Type of measurement, analyses, radionuclides	Sampling place	Sampling, measurements, sample	Number of samples, measurements, analyses
1. AIR			
1.1 Long-lived radionuclides ^{238}U, ^{226}Ra ^{210}Pb Aerosol monitoring station HR gamma spectrometry	Gorenja Dobrava	Continuously, quarterly composed sample	4
1.2. Radon (^{222}Rn)	Srednja vas (Čadež)	48 hours measurement,	2
	Gorenja vas	Semi-annually,	2
1.2.1. ^{222}Rn	Gorenja vas (Vršajn)		2
	Dolenja Dobrava		2
Charcoal detector	Gorenja Dobrava		2
HR gamma spectrometry	Todraž		2
	Pod transportnim trakom		2
	Brebovnica		2
	Bačenski mlin		2
	Debelo Brdo		2
	Reference location Ljublj.-Polje		2
	MP Jazbec		102
	SV brežina odlagališča, zgoraj		2
	Ograja nad vhodom v P-11		2
	Domačija Podlešan		2
	Potokar		2
	Kozolec Potokar		2
	MP Boršt		2
	Boršt zgoraj		2

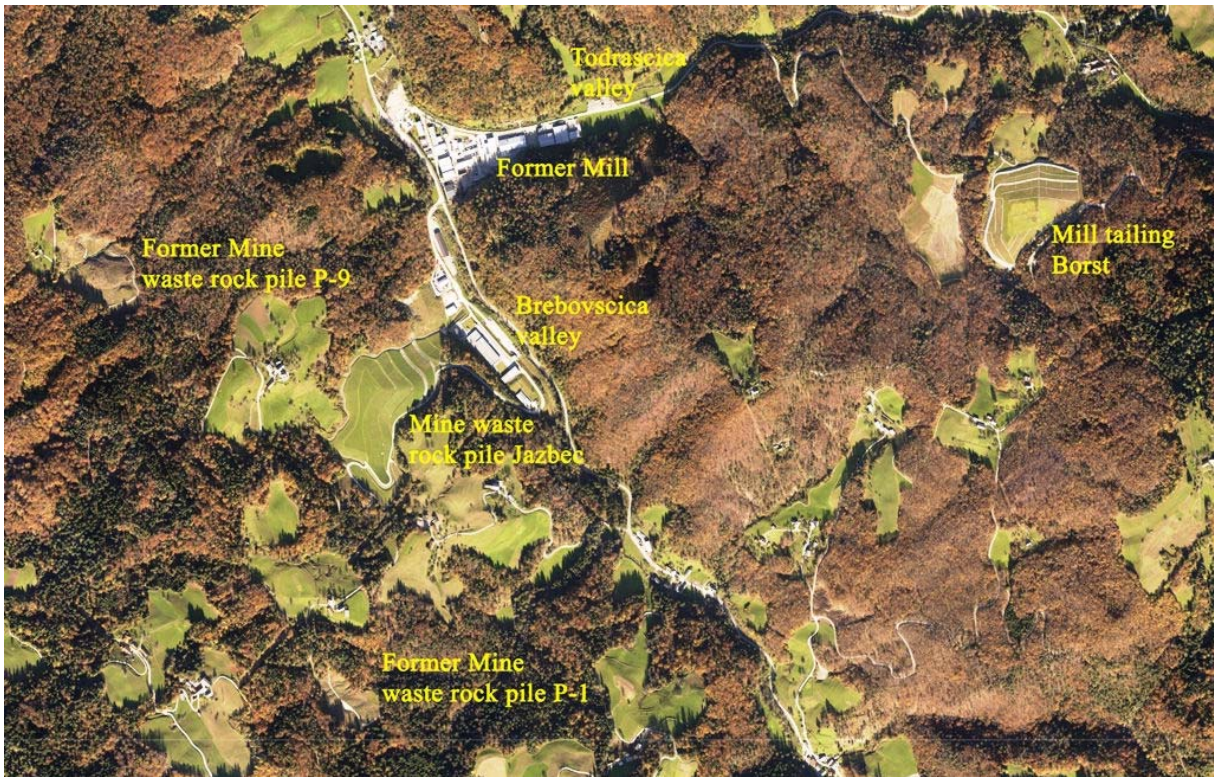
Type of measurement, analyses, radionuclides	Sampling place	Sampling, measurements, sample	Number of samples, measurements, analyses
1. AIR			
1.2.2. ^{222}Rn (Alpha track detector) 1, 2 or 3 detectors/sampling place)	Gorenja vas Dolenja Dobrava Gorenja Dobrava Todraž Pod transportnim trakom SV brežina odlagališča, zgoraj Brebovnica Bačenski mlin Debelo Brdo Reference location Ljublj.-Polje	Continuously, quarterly exchange	12 4 12 4 4 4 4 4 4 4
2. WATER – BREBOVŠČICA, TODRAŠČICA BROOK			
2.1. ^{238}U Dissolved, specific radiochemical analysis	Gorenja Dobrava Todraščica po	Continuously, daily grab sample, monthly composed sample	12 12
2.2. ^{226}Ra Dissolved, specific radiochemical analysis	Gorenja Dobrava Todraščica po	Continuously, daily grab sample, monthly composed sample	12 12
2.3. ^{210}Pb Dissolved, specific radiochemical analysis	Gorenja Dobrava Todraščica po	Continuously, monthly composed sample daily grab sample, quarterly composed sample	12 4
2.4. ^{210}Po Dissolved, specific radiochemical analysis	Gorenja Dobrava Todraščica po	Continuously, monthly composed sample	4 -

Type of measurement, analyses, radionuclides	Sampling place	Sampling, measurements, sample	Number of samples, measurements, analyses
2. WATER – UNDERGROUND WATER			
2.6. ^{238}U Dissolved, specific radiochemical analysis	Piezometer BS-30 Drmota Mrzlek	Grab sample, quarterly	1 1 1
2.7. ^{226}Ra Dissolved, specific radiochemical analysis	Piezometer BS-30 Drmota Mrzlek	Grab sample, quarterly	1 1 1
2.8. ^{210}Pb Dissolved, specific radiochemical analysis	Piezometer BS-30 Drmota Mrzlek	Grab sample, quarterly	1 1 1
3. SEDIMENTS – BREBOVŠČICA BROOK			
3.1. ^{238}U HR gamma spectrometry	Gorenja Dobrava	Continuously, Semi-annual sample	2
3.2. ^{226}Ra HR gamma spectrometry	Gorenja Dobrava	Continuously, Semi-annual sample	2
3.3. ^{210}Pb HR gamma spectrometry	Gorenja Dobrava	Continuously, Semi-annual sample	2
3.4. ^{230}Th HR gamma spectrometry	Gorenja Dobrava	Continuously, Semi-annual sample	2
4. FOOD - MILK			
4.1. ^{226}Ra Milk specific radiochemical analysis	Potokar farm Mine waste pile site Jazbec, Todraž/Gorenja Dobrava Reference location Bukovščica	Grab sample, annually	1 1 1 1

4.2. ^{210}Pb Milk specific radiochemical analysis	Potokar farm Mine waste pile site Jazbec, Todraž/Gorenja Dobrava Reference location Bukovščica	Grab sample, annually	1 1 1 1
Type of measurement, analises, radionuclides	**Sampling place**	**Sampling, measurements, sample**	**Number of samples, measurements, analyses**
5. EXTERNAL RADIATION, DOSE AND DOSE RATE			
5.1. External radiation TLD	Mine waste pile Jazbec Mill tailings site Boršt Todraž	Continuously, quarterly exchange	4 4 4
5.2. Vicinity of mill tailings site Boršt, sampling points	Vicinity of mill tailings site Boršt	Annually, Momentary dose rate	50

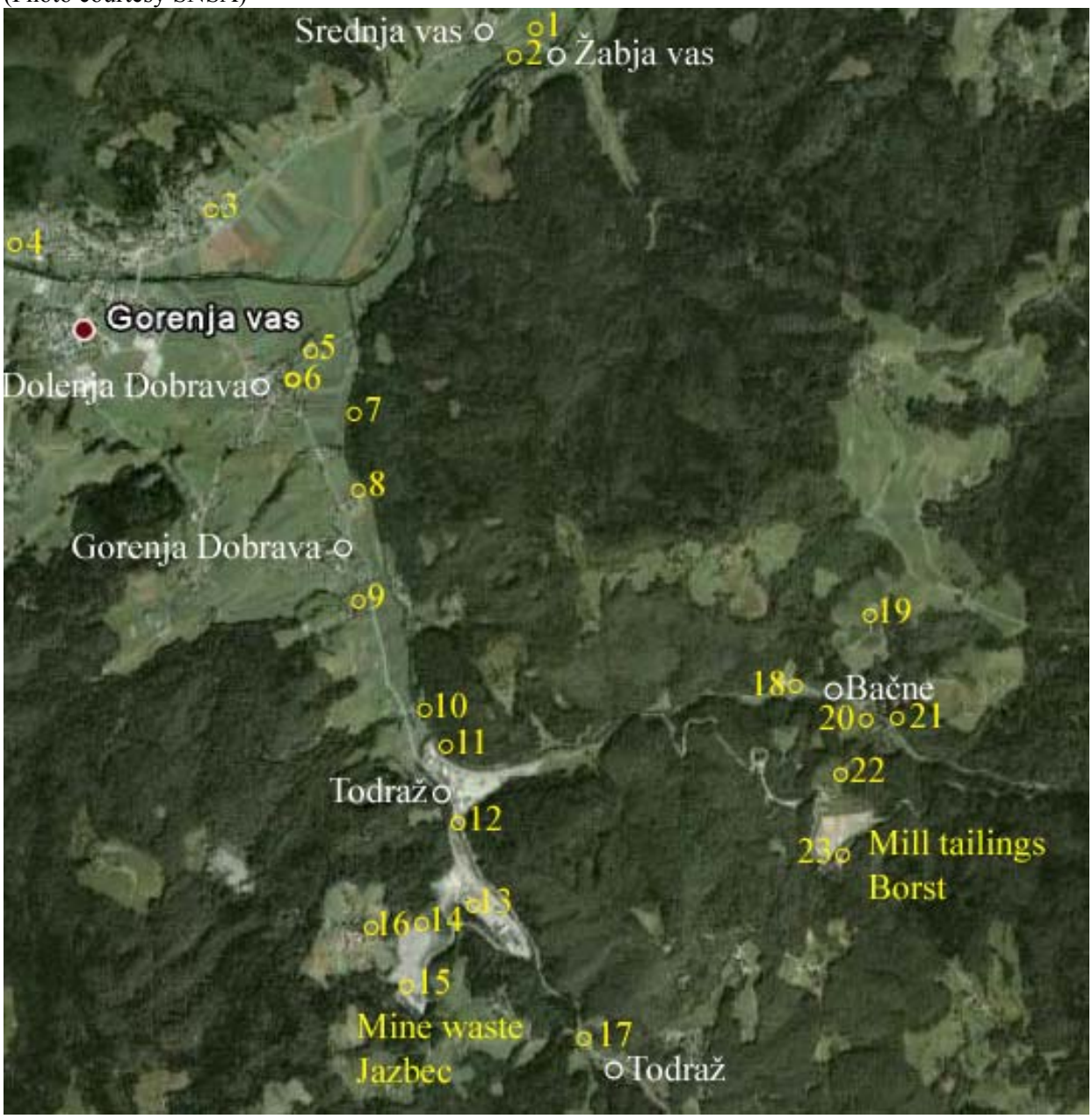
THE ŽIROVSKI VRH URANIUM MINE WITH THE FORMER AND EXISTING MINE OBJECTS, NOVEMBER 2010

(Photo courtesy SNSA)



SAMPLING AND MEASUREMENT POINTS IN THE VICINITY OF THE ŽIROVSKI VRH URANIUM MINE (PHOTO 2003)

(Photo courtesy SNSA)



1 Srednja vas (Cadez)
2 Sora po
3 Gorenja vas
4 Gorenja vas (Vršajn)
5 Drmota
6 Dolenja Dobrava
7 Mrzlek
8 Gorenja Dobrava
9 Gorenja Dobrava/Todraz)
10 Todraz
13 MP Jazbec
14 SV brezina odlagalisca, zgoraj
15 Ograja nad vhodom v P-11
16 Domacija Podlesan
17 Brebovnica
18 Bacenski mlin
19 Debelo Brdo
20 Potokar Farm
21 Potokar
22 Kozolec Potokar, MP Borst

11 Todrascica po
12 Pod transportnim trakom
23 Borst zgoraj

Control point	Measurement, sampling
1	Radon
2	Water (not in monitoring programme for 2011)
3	Radon, water
4	Radon
5	Water
6	Radon
7	Water
8	Radon, aerosols, water, sediments
9	Milk
10	Radon, aerosols, external gamma radiation (TLD; dose rate probe - URSJV), water
11	Water
12	Radon
13	Radon, aerosols
14	Radon, external gamma radiation
15	Radon
16	Radon, milk
17	Radon
18	Radon
19	Radon, aerosols
20	Milk
21	Radon
22	Radon, aerosols, external gamma dose, weather station
23	Radon

PROGRAMME OF MINE, SEEPAGE AND UNDERGROUND WATER MONITORING, SAMPLING AND MEASUREMENT POINTS

(Photo courtesy SNSA)

1 Brebovcica po	10 J-3/2
2 Brebovščica + Jazbec	11 ZDZ
3 Brebovščica pred	12 SDB
4 Todraž PO	13 Tunel
5 Brebovščica pred	14 Borst potok glavni (BPG)
6 JV P-10	15 P-9 (izvir)
7 Jazbec	16 P-9 (podkop + pod in nad)
8 SDIJ	17 P-i (podkop)
9 ZDV	18 P-11 (podkop)

APPENDIX 4

SLOVENIAN DOSE RATE, AIR ACTIVITY AND TLD MONITORING NETWORKS

(Maps courtesy SNSA)

Fig. 1: Automatic monitoring stations for ambient dose equivalent rate:

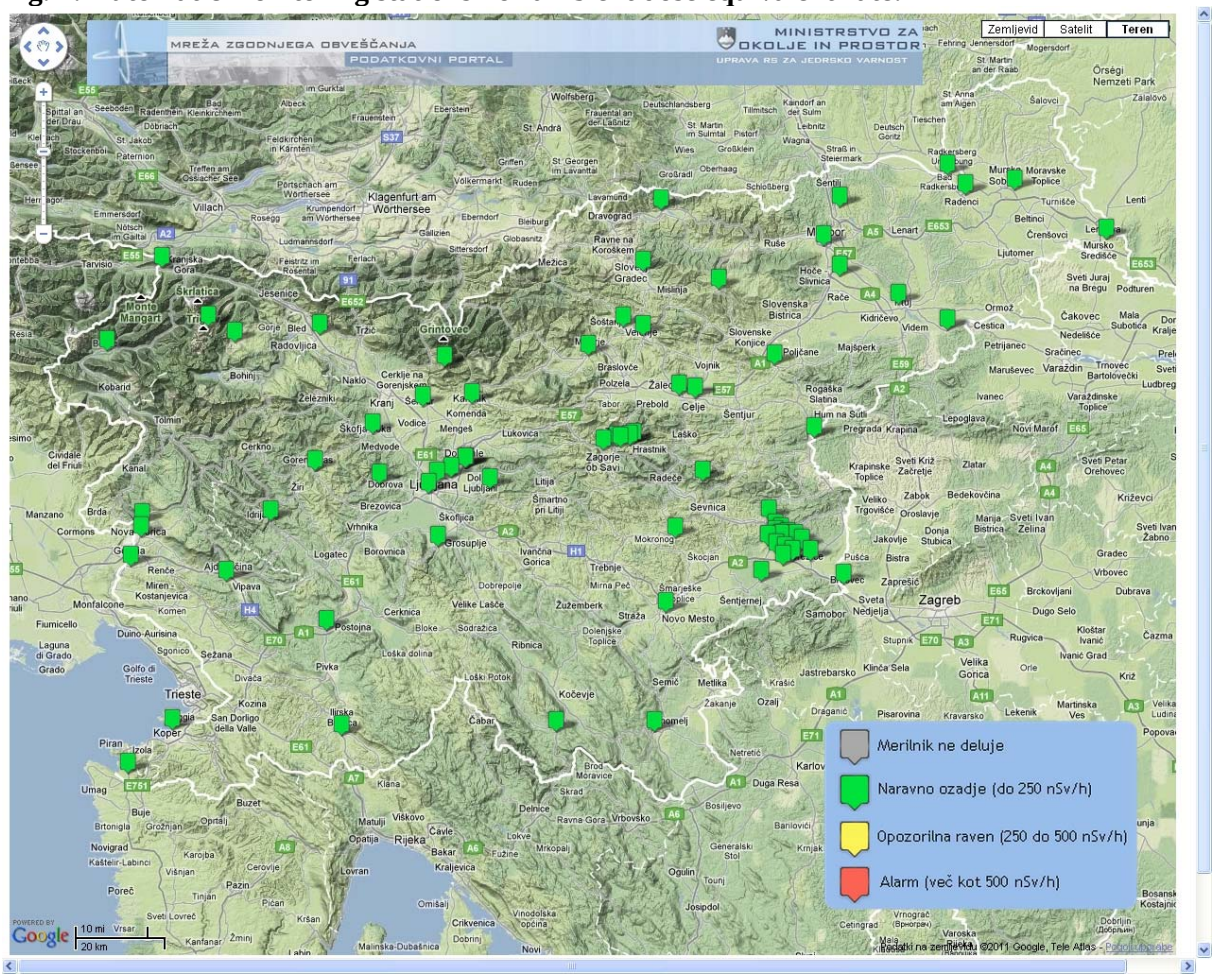
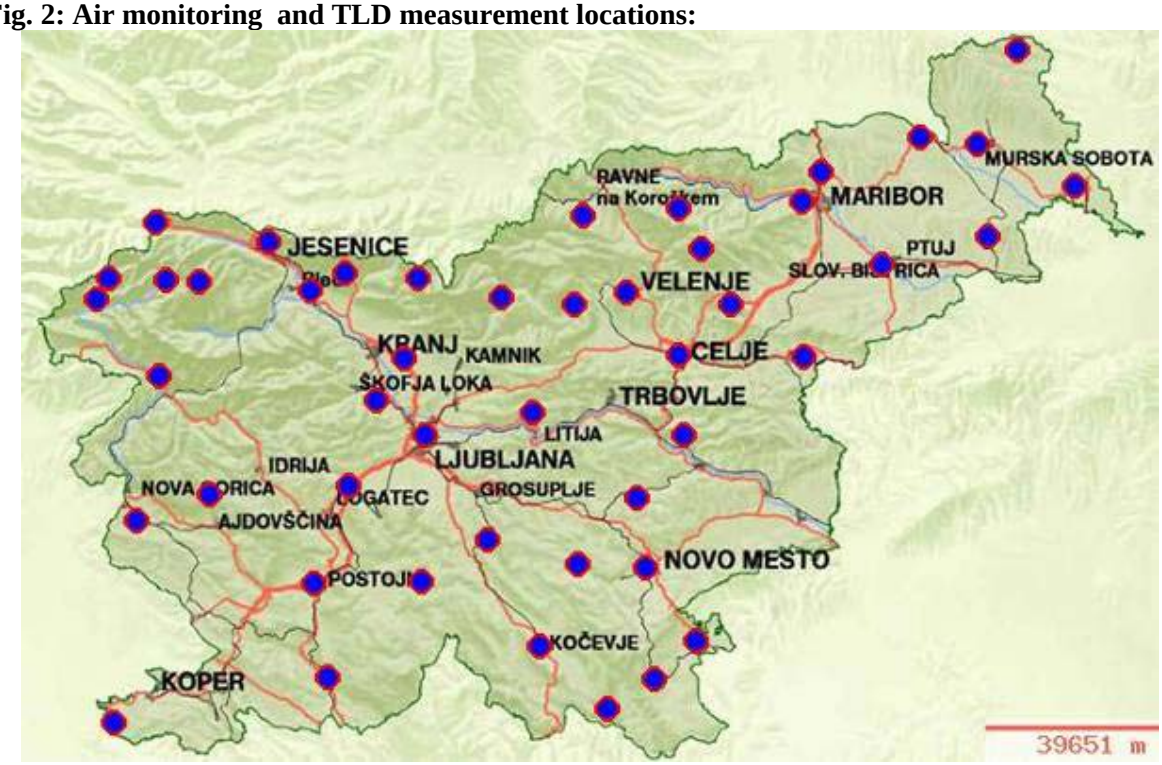


Fig. 2: Air monitoring and TLD measurement locations:



APPENDIX 5

SLOVENIAN LABORATORY BASED ENVIRONMENTAL RADIOACTIVITY MONITORING NETWORK

(Maps courtesy SNSA)

Fig. 1: Locations for surface water sampling:

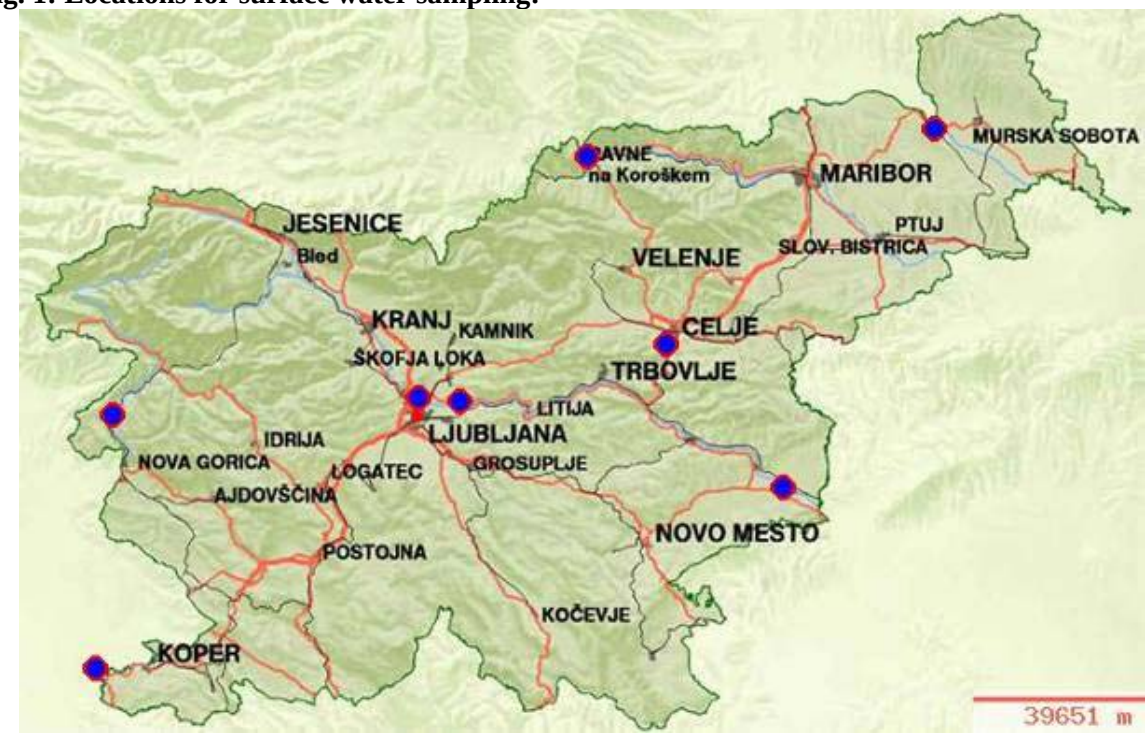


Fig. 2: Locations for soil and precipitation sampling:

Fig. 3: Locations for drinking water sampling:

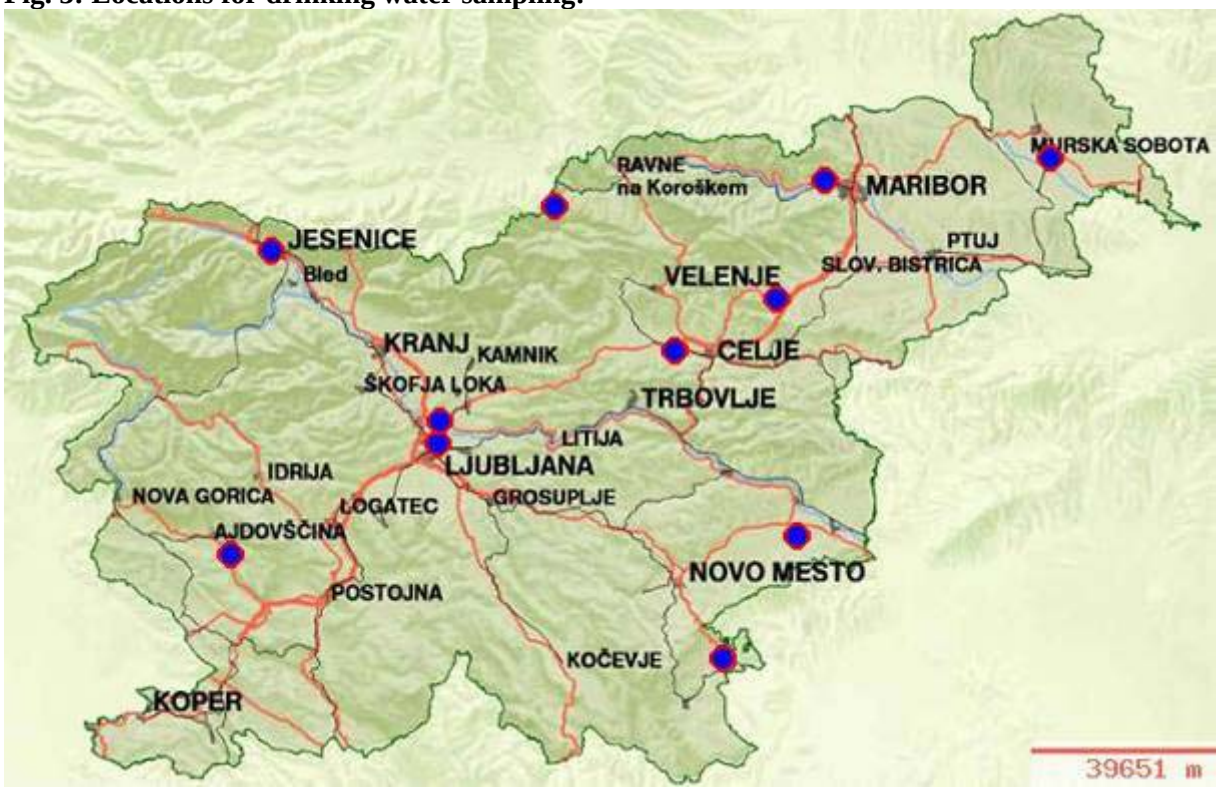


Fig. 4: Locations for food and feeding stuff sampling: