EUROPEAN COMMISSION
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D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

ESTONIA
Tallinn

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

23 - 25 September 2020

Reference: EE 20-01

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	Tallinn, Estonia
DATES	23 – 25 September 2020
REFERENCE	EE 20-01
TEAM MEMBERS	Mr V. Tanner
REPORT DATE	13 January 2021
SIGNATURES	

V. Tanner

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Abbreviations

CBRN	Chemical, Biological, Radiological, Nuclear
EB	Environmental Board
EC	European Commission
EURDEP	EUropean Radiological Data Exchange Platform
GM	Geiger-Müller
HPGe	High-purity Germanium
IAEA	International Atomic Energy Agency
JRC	Joint Research Center
LIMS	Laboratory Information Management System
MDA	Minimum Detectable Activity
NaI	Sodium-Iodine (Detector)
REM	EC Radioactivity Environment Monitoring database
RT	Estonian government official journal
TLD	Thermoluminescent dosimeter

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 Estonia of its decision to conduct an Article 35 verification in a letter addressed to the Estonia Permanent Representation to the European Union. The Estonian Environmental Board was designated to lead the preparations for the visit.

2.2 DOCUMENTS

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

2.3 PROGRAMME OF THE VISIT

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

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[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 1 September 2020

The opening meeting included presentations on the Estonian automatic radiation monitoring system and other environmental radioactivity monitoring arrangements. The verification team pointed to the quality and comprehensiveness of all the presentations and documentation.

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

Ministry of the Environment

- Ms Maria Leier, Senior Officer of the Ambient Air and Radiation Department

Environmental Board

- Mr Ilmar Puskar, Head of the Radiation Safety Department
- Ms Monika Lepasson, Head of the Radiation Monitoring Bureau of the Radiation Safety Department
- Ms Eia Jakobson, Head of the Laboratory of the Radiation Monitoring Bureau of the Radiation Safety Department
- Mr Uko Rand, Chief Specialist of the Radiation Monitoring Bureau of the Radiation Safety Department
- Mr Teet Koitjärv, Crisis Management Adviser of the Radiation Safety Department

Estonian Environment Agency

- Ms Anastasia Petrova, Leading Specialist of the Environmental Analysis Department

Veterinary and Food Board

- Ms Merle Laurimaa, Chief Specialist of the Food Department
- Ms Jelena Sõgel, Leading Specialist of the Food Department

Information Technology Centre of the Ministry of the Environment

- Mr Risto Raaper, Head of the Infrastructure Department
- Mr Andero Belov, System Administrator

University of Tartu

- Mr Madis Kiisk, Head of the Research Unit
- Ms Siiri Suursoo, Researcher in radiation protection

Estonian Rescue Board

- Ms Ruti Enn, Chief Specialist of the CBRN Group
- Mr Raido Taalmann, Chief, Estonian Northern-Regional Bomb Group

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING IN ESTONIA

3.1 LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

The list below presents the Estonian legislation and guidance that form the basis for environmental radioactivity monitoring.

Acts

- Radiation Act (RT I, 28.06.2016, 2)
  English version: https://www.riigiteataja.ee/en/eli/513012020008/consolide/current
- Environmental Monitoring Act (RT I, 18.05.2016, 1)
  English version: https://www.riigiteataja.ee/en/eli/507012019005/consolide/current
- Environmental Supervision Act (RT I 2001, 56, 337)
  English version: https://www.riigiteataja.ee/en/eli/521032019008/consolide/current

Regulations of the Government

- Limits on the effective dose to radiation workers and residents and to the equivalent dose to the lens, skin and limbs (RT I, 20.09.2016, 9)
  Estonian version: https://www.riigiteataja.ee/akt/131072018012.

Regulations of the Minister of the Environment

- Surveillance and assessment of the effective dose of radiation workers and members of public, dose coefficients of doses from intake and radiation and tissue weighting factors (RT I, 22.11.2016, 22)
  Estonian version: https://www.riigiteataja.ee/akt/122112016022
- Requirements and procedure for the implementation of the national environmental monitoring program and subprograms (RT I, 25.01.2017, 9)
  Estonian version: https://www.riigiteataja.ee/akt/125012017009
- Specified requirements and procedure for designation and protection of the state environmental monitoring station and area (RT I, 18.11.2016, 7)
  Estonian version: https://www.riigiteataja.ee/akt/118112016007

List of legislative acts establishing the responsibilities of the various actors in this domain

- Statutes of the Ministry of the Environment (RT I 2009, 63, 412)
  Estonian version: https://www.riigiteataja.ee/akt/121052019002?leiaKehtiv
- Statutes of the Environmental Board (RT I, 27.05.2014, 1)
  Estonian version: https://www.riigiteataja.ee/akt/118122020013
- Statutes of the Health Board (RT I, 20.11.2018, 2)
  Estonian version: https://www.riigiteataja.ee/akt/120112018002
- Statues of the Veterinary and Food Board (RT I, 23.08.2018, 1)
  Estonian version: https://www.riigiteataja.ee/akt/125082020007
- Statutes of the Environment Agency (RT I, 02.07.2015, 1)
  Estonian version: https://www.riigiteataja.ee/akt/102072015001

3.2 LEGISLATIVE ACTS REGULATING RADIOLOGICAL SURVEILLANCE OF FOOD

The list below presents the Estonian legislation and guidance that form the basis for the radiological surveillance of food and foodstuffs.

Acts

- Food Act (RT I 1999, 30, 415)
  English version: https://www.riigiteataja.ee/en/eli/ee/513012020002/consolide/current

Regulations of the Minister of Agriculture

- Rules of Procedure for the Regulation of Monitoring of Contaminants in Foodstuffs of Animal Origin and Methods for Taking of Control Samples and Analysing thereof (RT I, 28.06.2014, 72)
  Estonian version: https://www.riigiteataja.ee/akt/115112019002?leiaKehtiv
- Methods of analysis for the determination of contaminants in food of animal origin (RT I, 28.11.2014, 12)
  Estonian version: https://www.riigiteataja.ee/akt/128112014012

Regulations of the Government

- Intervention and action levels and reference levels for emergency exposure in the event of a radiological emergency (RT I, 20.09.2016, 7)
  Estonian version: https://www.riigiteataja.ee/akt/131072018011

List of legislative acts establishing the responsibilities of the various actors in this domain

- Statues of the Veterinary and Food Board (RT I, 23.08.2018, 1)
  Estonian version: https://www.riigiteataja.ee/akt/125082020007

3.3 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. 2011, World Health Organisation (WHO)

4 BODIES HAVING COMPETENCE IN RADIOACTIVITY MONITORING

4.1 MINISTRY OF THE ENVIRONMENT

Radiation protection and safety in Estonia is organized by the Ministry of the Environment, which is responsible for developing national policies and legislation. The Minister of the Environment approves the National Environmental Monitoring Program; the National Radiation Monitoring Program is a subprogram of this main program. The activities related to radiation safety are organised by the Ministry of the Environment within the limits of its competence through the Environmental Inspectorate and the Environmental Board.[4]

National environmental radiation monitoring is organized and coordinated also by the Ministry of the Environment within the limits of its competence through the Environment Agency.

The Ministry of the Environment in cooperation with the environmental company Ökosil Ltd organises radiation monitoring at the re-vegetated remediated tailing pond area in Sillamäe (monitoring in Sillamäe is not part of the National Radiation Monitoring Program).

4.2 ENVIRONMENTAL BOARD

4.2.1 General

The Environmental Board (EB) is a government agency under the Ministry of the Environment. Its main office and its Radiation Safety Department are located in Tallinn (the Environmental Board also has other offices across Estonia).

Main task of the Board is to exercise national environment use, nature protection and radiation safety policies, and to contribute to the preparation and improvement of environmental legislation and other related official documents. The Board became operational on 1st February 2009. It was established by merging the former Environmental Services, the Nature Conservation Centre and the Radiation Protection Centre.

The Environmental Board is the national competent authority in the field of radiation protection and radiation safety. It has the following functions:

- Issue radiation practice licenses
- Implement the radiation monitoring act as an advisory body on radiation safety issues in Estonia
- Manage the emergency notification and early warning system
- Coordinate the response to nuclear or radiological emergencies

The Environmental Board is also the competent authority towards implementation of radiation protection requirements in Estonia pursuant of the Euratom Treaty.

According to the National Emergency Response Plan, the responsibilities of the Environmental Board in the case of an emergency are to lead the emergency response, to organize radiation monitoring, to ensure the identification of radioactively contaminated areas, and to model the distribution of the contamination.

4.2.2 Radiation Safety Department of the Environmental Board

Radiation protection and radiation safety issues are dealt with by the Radiation Safety Department, which consist of two bureaus – the Radiation Monitoring Bureau and the Radiation Protection Bureau.

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[4] In 2020, the Estonian government made the decision to consolidate the Environmental Board and Environmental Inspectorate in January 2021.

The main tasks of the Radiation Protection Bureau are processing of applications of radiation practice licenses and preparation of radiation safety assessments.

The main tasks of the Radiation Monitoring Bureau are organisation of the radiation monitoring of the environment, organisation of early warning of radiation emergencies, emergency preparedness and response, laboratory analyses, and monitoring of personal doses of radiation workers. It is responsible for composition and implementation of the National Radiation Monitoring Program, in line with the national legislation and international agreements. In case of discovered immediate dangers or threats, it informs the relevant agencies, the general public and international partners. The Bureau is also responsible for composing annual monitoring reports, publishing the monitoring results, updating the EC REM-database and submitting monitoring data to the EURDEP system.

Radiation monitoring is carried out under annual programs, which are approved by the head of the Radiation Safety Department. Monitoring is financed from the state budget (the budget of the Environmental Board).

For environmental sample collection, the bureau cooperates with other governmental organisations and universities. Milk samples are collected by the Veterinary and Food Board, air filter samples by the Environment Agency and by contracted private citizens; marine environmental samples are collected by the Department of Marine Systems of the Tallinn University of Technology. The personnel of the Radiation Monitoring Bureau take all other samples.

All samples, which are collected under the National Radiation Monitoring Program, are analysed in the EB radiological laboratory, which is part of the Radiation Monitoring Bureau. Annually almost 300 environmental samples are analysed at the laboratory. The laboratory has ISO 17025 accreditation in the field of gamma-spectrometry.

The Radiation Monitoring Bureau employs a staff of 8 – head of the bureau, head of the laboratory, 2 laboratory specialist, 2 personal dosimetry specialists and 2 radiation monitoring specialist (one of them is specialised mainly in Radon monitoring).

4.3 ENVIRONMENTAL INSPECTORATE

The Environmental Inspectorate is a government agency under the Ministry of the Environment. It has its main office in Pärnu and other offices across Estonia. It supervises fulfilment of the conditions of radiation practice licenses by the licensees (including environmental radiation monitoring; it also has rights to take samples during inspections) and has enforcement powers.

4.4 ENVIRONMENT AGENCY

The Environment Agency is a government agency under the Ministry of the Environment. It has its main office is in Tallinn and other offices across Estonia.

The tasks of the Environment Agency are to organize the implementation of the National Environmental Monitoring Program, collection of environmental monitoring data, processing and analysis of information on the environment and the factors influencing it, preparation of assessments on the state of the environment and provision of vital services, including weather forecasting.

The Environment Agency maintains the national Environmental Monitoring Database KESE, which contains also radiation data.

Under a contract with the Environmental Board the Environment Agency personnel changes the filters at the air filter stations. Most of the automatic monitoring stations which belong to the Environmental Board are located on the meteorological fields of the Environment Agency.

4.5 HEALTH BOARD

The Health Board is a government agency under the Ministry of Social Affairs. The Health Board's main office is located in Tallinn and it has other offices across Estonia. It contributes to health care and ensures health protection, environmental health, chemical safety, and safety of medical devices in Estonia through pre-emptive and complaint-based supervision in the aforementioned domains.

The Health Board is responsible for the monitoring of drinking water quality. The obligation to monitor radionuclides in drinking water is imposed to the water suppliers. The Health Board arranges national research if needed.

According to the National Emergency Response Plan, the Health Board is responsible, in cooperation with the Environmental Board, for arranging the monitoring of drinking water radioactivity in the event of an emergency.

4.6 VETERINARY AND FOOD BOARD

The Veterinary and Food Board is a government agency under the Ministry of Rural Affairs. It has its main office in Tallinn and other offices across Estonia. It functions as a supervising body and ensures that the requirements stipulated by the legislation that governs veterinary medicine, food safety, market regulation, animal welfare and farm animal breeding are followed, and applies enforcement by state pursuant to the procedures and in the amounts prescribed by law.

According to the National Emergency Response Plan, the Veterinary and Food Board is responsible, in cooperation with the Environmental Board, for arranging the monitoring of food- and feedstuff radioactivity. Radiological surveillance of foodstuffs covers milk and imported food from third countries. Milk samples are collected by the Veterinary and Food Board and analysed by the Environmental Board. Milk monitoring is also a part of national radiation monitoring program. Imported food from third countries for human consumption is analysed by the Agricultural Research Centre.

As of 1 January 2021, the Veterinary and Food Board and the Agricultural Board were consolidated and renamed as the Agriculture and Food Board.

5 RADIOACTIVITY MONITORING IN ESTONIA

5.1 INTRODUCTION

Estonia has no nuclear programme, but the legacy of the Soviet Union has left it with several radioactivity-related environmental issues, most important being the former naval nuclear training centre site at Paldiski and the Sillamäe uranium mining tailings pond.

There are several operational nuclear reactors close to Estonia, so monitoring of radioactivity in the environment is well justified. Monitoring of radioactivity in environment and foodstuffs includes surveillance of artificial radiation and artificial radionuclides. Exposure to natural radiation is monitored by research activities if there is reason to suspect that natural radionuclides may cause unusually high exposure to the public (e.g. indoor Radon and natural radionuclides in drinking water).

Due to the small area of the country and the fact that contamination of the Estonian environment may occur as result of a large-scale radiological or nuclear accident in a neighbouring country, the whole territory is dealt with as one representative geographical region.

In accordance with the Commission Recommendation 2000/473/EURATOM, the following samples are collected and analysed in the context of radiation monitoring: air, surface water, drinking water, milk, food and soil; and in addition, the gamma radiation dose rate in ambient air is continuously monitored. Estonia has joined the Convention on the Protection of the Marine Environment of the Baltic Sea Area

(HELCOM) and in accordance with the HELCOM Recommendation 26/3, seawater, biota and sediment samples are collected and analysed.

According to the Environmental Monitoring Act, the National Environmental Monitoring Program consists of sectoral subprograms; one of them is the Radiation Monitoring Program, which is managed by the Environmental Board. The Environmental Board also carries out independent monitoring around the territory of A.L.A.R.A. Ltd (Estonian Radioactive Waste Management Organisation).

According to the Radiation Act, a radiation practice licence holder has an obligation to carry out radiation monitoring. In the application process for a license, the applicant is required to provide a radiation monitoring programme including information about measuring devices. The Environmental Board reviews and approves the monitoring programme. The facilities maintain records of the monitoring results and estimated doses to the public and store them throughout their entire activity. They report immediately to the Environmental Board if the records exceed limits and conditions relating to public exposure, and they have an emergency plan for unexpected increases in radiation levels in the environment. The Environmental Board reviews periodic reports, which the licensees are required to submit once a year.

Research on the presence of natural radionuclides in the environment is mainly in the framework of scientific research carried out by the universities. Radiation monitoring also includes determining levels of the most common naturally occurring radionuclides in order to assess the radiation doses to the population from naturally occurring radionuclides.

5.2 MONITORING OF AMBIENT RADIATION DOSE AND DOSE RATE

Since 2014, the Environmental Board operates 15 automatic monitoring stations (SARA AGS711F, manufactured by Envinet GmbH) to measure ambient gamma dose rate in real time. There is one monitoring station in Tallinn on the territory of the Environmental Board and 14 stations outside Tallinn spread evenly across the Estonian territory (Fig. 1). The locations of the monitoring stations have been chosen to cover the border areas of Estonia and to be close to major cities.

All monitoring stations use a Geiger-Müller detector as a measuring detector for the total gamma dose rate (nSv/h) and a NaI(Tl) crystal detector that measures gamma radiation energy spectrum, allowing identification of radionuclides and distinguishing between dose rates generated by different radionuclides.

In the event of radiation level exceeding the alert level, the monitoring station automatically reports to the 24/7 surveillance team (duty officers) of the Environmental Board Radiation Safety Department, which analyses the information and inform other relevant authorities and the general public, if necessary. Data is transmitted from monitoring stations every 10 minutes via the GSM network to the server of the Information Technology Centre of the Ministry of the Environment (KeMIT[5]) and can be monitored by using a special software. In each monitoring station, it is possible to adjust the integration time of the measurements, the data transmission interval and the alert level thresholds.

Most of the monitoring stations are located in the meteorological stations of the Environment Agency. Measurements are taken in open terrain at about 1.5 meters above ground (except the Tallinn Station on the territory of the Environmental Board, which is about 5 m above ground).

[5] KeMIT is the authority under the Ministry of Environment, which supports the Ministry and its sub-authorities on the IT field.

Dose rate information is publicly available on the webpage of the Environmental Board in Estonian[6] and on the EURDEP webpage. Annual radiation monitoring reports with explanations and graphics are compiled and published on the webpage of the Environmental Board in Estonian[7].

Technical specifications of the monitoring station are the following:

Energy range

- Spectroscopic Gamma detector: 30 keV to 3 MeV.
- Geiger-Müller detector: 50 keV to 1.3 MeV

Detection Range

- Geiger-Müller detector 4 µSv/h … 1 Sv/h (+/- 15%)
- Spectroscopic Gamma detector 1 nSv/h … 100 µSv/h (+/- 10%)

Nuclide identification

Every spectrum (10 minutes, 1 hour, 24 hours) is analysed by a peak searching algorithm. The detected peaks are compared to a user configurable nuclide library for identification. If peak(s) is/are assigned to a nuclide, the nuclide specific dose rate in µSv/h and the activity in Bq/cm^2 is automatically calculated and stored.

Alarm threshold levels

An alarm is triggered when the measured radiation levels are above the set threshold levels. The SARA system allows defining and configuring individual thresholds for the ambient dose rate and for the nuclide specific dose rate.

Data transmission

The measured data is transmitted to the network server in 10-minute intervals via GPRS.

Ensuring network continuous functioning

Continuous functioning of the network is described in an internal document "*Risk analysis and continuity plan of vital services*", which includes information about risks that may cause various system malfunctions, and includes a plan how system continuity is guaranteed. The document is managed by KeMIT, which handles most of the IT malfunctions. There is also a service level agreement between the service provider (KeMIT) and the Environmental Board, which includes deadlines of how quickly the system must be restored and how quickly specific types of errors must be responded to. The Environmental Board takes care of all types of station hardware issues.

Maintenance

There is a contract between KeMIT and the system manufacturer Envinet GmbH, which covers both software and hardware issues. In addition, there is a system software tool, which checks continuous system operation once a day and compiles a report about main findings or malfunctions. The tool is working independently from the server. That way the system avoids accumulation of errors that may stop or damage the server operation.

In case one or more stations are not working properly, duty officer of the Environmental Board gets SMS and email notifications about stations that are out of order or have difficulties communicating with the server. With some delay, that information is also generated by the EURDEP server and sent to designated emails.

[6] https://www.keskkonnaamet.ee/et/eesmargid-tegevused/kriisireguleerimine/varajane-hoiatamine

[7] https://www.keskkonnaamet.ee/et/eesmargid-tegevused/kiirgus/aruanded-ja-uuringud

The Environmental Board checks stations' hardware physically once in 2-year periods and carries out all on-site works. This includes replacing malfunctioned parts and sending them to factory for repair or replacement.

To ensure quality of the measurement results, test measurements are carried out at monitoring stations every other year using a dedicated ^{137}Cs test source. Energy calibrations are carried out using natural ^{40}K.

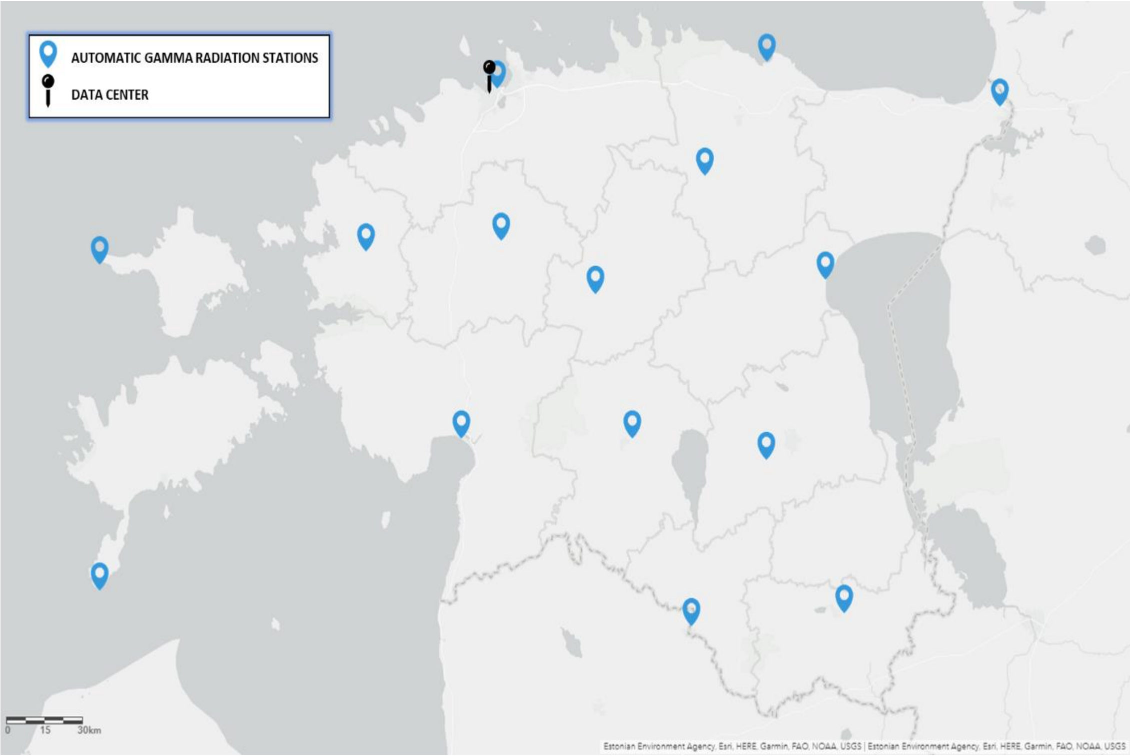

Figure 1. Estonian nationwide network of automatic dose rate monitoring stations

5.3 Monitoring of Air

Estonia has three modern aerosol collectors (Figures 2 and 3). Type Snow White JL-900 (manufactured by Senya Oy) high-volume samplers are located in Harku (Tallinn) and Narva-Jõesuu; a Hunter JL-150 (manufactured by Senya Oy) medium-volume sampler is located in Tõravere.

All filter stations collect air particulates on a glass microfiber filter. The systems pump a large amount of air through the filter (24/7) and radioactive particulates are deposited on the filter. Sample collection time is usually (in a normal situation) one week; the filter is then analysed by gamma-spectrometry to accurately identify radionuclides, which were present in the air and to determine their activity concentrations (Bq/m^3).

Two stations (Harku and Tõravere) are located on the meteorological fields of the Environment Agency and the workers of the Environment Agency change the filters. One station (Narva-Jõesuu) is located on the territory of Estonian Police and Border Guard Board and a worker of the Estonian Police and Border Guard Board changes the filter. Usually the filters are sent by post to the laboratory of the Environmental Board.

Atmospheric radioactivity levels are usually very low and the monitoring method used can often measure only the activity concentration of the natural cosmogenic radionuclide ^{7}Be (which is always present in the atmosphere) and the artificial radionuclide ^{137}Cs. Thus, the activity concentrations of the said radionuclides are always reported. Other radionuclides expressing radioactive contamination are also monitored and if identified; their activity concentrations are determined.

In case of a threat or in emergency situations, the frequency of filter change may be adjusted from one week to a shorter period, depending on the situation.

If there is reason to suspect presence of gaseous radioactive iodine in air (reactor emergency), the air samplers can be equipped with charcoal filters, which collect gaseous iodine from the airflow.

Continuous operation of stations is ensured by contracts or agreements with filter changers on information exchange in case of visible malfunctions of equipment, or other abnormalities like power supply failures. Regular routine maintenance is carried out by the Environmental Board. Tables I – III present the main technical data of the air samplers.

Table I. Air sampling stations

Location	Measurements started (year)	Current situation
Harku (Tallinn)	1995	In 2014, older equipment manufactured by local scientists was replaced by Snow White JL-900.
Narva-Jõesuu	1996	In 2014, system went through full modernization – main electrical parts were replaced.
Tõravere	1997	In 2016, system went through full modernization – main electrical parts were replaced.

Table II. Technical specifications of the air samplers

Type	Snow White JL-900	Hunter JL-150
Pump type	Gas Ring Vacuum	Gas Ring Vacuum
Standard flow rate volume	900 m^3/h, filter dependent	150 m^3/h
Standard filter size	570 x 460 mm	230 × 285mm
Carbon filter	Available, not used routinely	Available, not used routinely
Carbon cartridge volume	0.5 L	

Table III. Other information on the air samplers

	Snow White JL-900	Hunter JL-150
Location	Harku and Narva-Jõesuu	Tõravere
Particle filter type	Whatman GF/A (glass microfibre filter)	
Exposure time (in normal situation)	1 week	
Number of samples annually	52	

Figure 2. Locations of aerosol monitoring stations

Figure 3. Snow White JL-900 air sampler in Harku

5.4 MONITORING OF WATER

5.4.1 Surface waters

Radioactivity of surface waters is monitored both in inland water and in seawater. For inland water monitoring, two sampling stations are located at the two largest rivers of the country: Narva river which flows into the Gulf of Narva and Pärnu river which flows into the Gulf of Pärnu (Table IV, Figure 4). Monitoring allows assessing the level of radioactivity in surface water and provides information on how radionuclides behave in the aquatic environment. Monitoring of two different rivers shows whether there are regional differences in the deposition of radionuclides in surface water.

The water in the Narva river represents a very large basin (approximately 56 200 km^2), including Estonian and Northwest Russian areas that were contaminated by the Chernobyl nuclear accident. The Pärnu river basin (approximately 6920 km^2) has radioisotopes deposited mainly from global atmospheric pollution. The monitoring stations on rivers have been selected to exclude the effects of seawater in the samples.

Water samples are collected from the rivers quarterly by the Environmental Board. Activity concentration of ^{137}Cs is measured. The samples are taken from the surface layer.

Table IV. River water radiation monitoring

Monitoring station	Time of sampling	Samples annually	Amount of sample	Analysed nuclides, Measurement unit
Pärnu river water Narva river water	March May August October	4	30 litres per sample	^{137}Cs Bq/l

5.4.2 Sea water

Radioactivity in the marine environment is monitored on the area of the Gulf of Finland by taking samples once a year from five different locations (Table V, Figure 4). Monitoring in the marine environment is implemented according to the HELCOM Recommendation 26/3[8].

Marine samples are taken by the Tallinn University of Technology, Department of Marine Systems. The Environmental Board and the Tallinn University of Technology have an annual contract for the sampling. The samples are taken from the surface layer.

Table V. Marine water sampling locations

Monitoring station	Coordinates		Samples annually	Amount of sample	Analysed nuclides, Measurement unit
	North latitude	East longitude			
N8	59° 28' 30"	28° 00' 30"	1	50 litres per sample	^{137}Cs, ^{40}K Bq/m^3
EE17	59° 43' 00"	25° 01' 00"			
PE	59° 22' 48"	24° 09' 18"			
PW	59° 20' 30"	24° 02' 00"			
23b	59° 18' 18"	23° 17' 18"			

8 HELCOM Recommendation 26/3, Monitoring of radioactive substances, 2005

Figure 4. River and seawater sampling locations

5.4.3 Ground water

Ground water radioactivity monitoring in Estonia is carried out only at the two nuclear legacy sites. The Environmental Board analyses well water from boreholes and drainage water (Table VI) collected from the near vicinity of state-owned Radioactive Waste Management Organisation A.L.A.R.A. Ltd. Sampling locations PA1, PA6, PA9 (Figure 5) and T-PA (Figure 6) represent the upper level of ground water, located on the territory of A.L.A.R.A. Ltd. Maximum depth of these boreholes is approximately 10 metres. Sampling location "Suubla" represents a drainage water originated from the Paldiski site (Figure 5). This is the so-called independent monitoring by the Environmental Board, which is carried out in addition to the monitoring carried out by the holder of the radiation practice license A.L.A.R.A. Ltd.

In addition to the regular monitoring programme, the University of Tartu has carried out research sampling programmes of deep groundwater in the north Estonia, which is known to have high concentrations of ^{228}Ra due to specific geological conditions.

Table VI. Ground and drainage water sampling locations related to A.L.A.R.A. Ltd.

Monitoring station	Sampling name	Time of sampling	Samples annually	Amount of sample	Analysed nuclides, Measurement unit
Paldiski site	PA 1	March May August October	4	1 litre per sample	^{3}H Bq/l
	PA 6				
	PA 9				
	Suubla				
Tammiku site	T-PA				

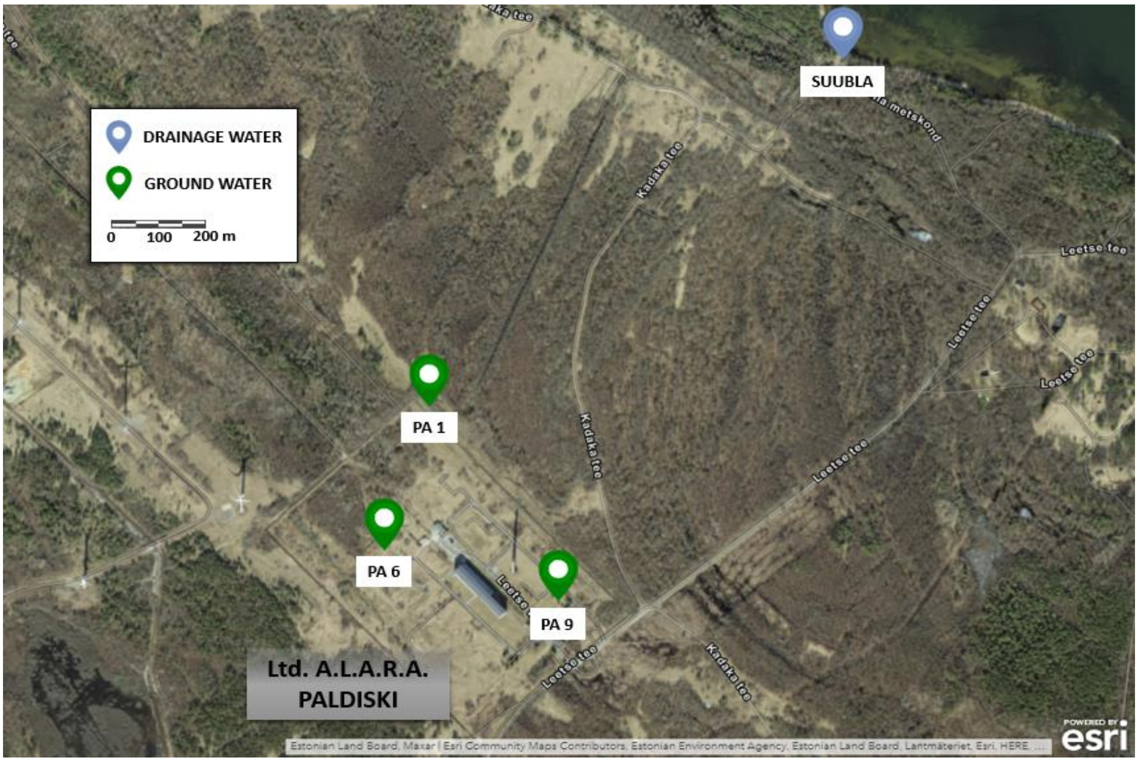

Figure 5. Water sampling locations at or in vicinity of the Paldiski Site (A.L.A.R.A. Ltd.), located at Lääne-Harju parish, Harju County

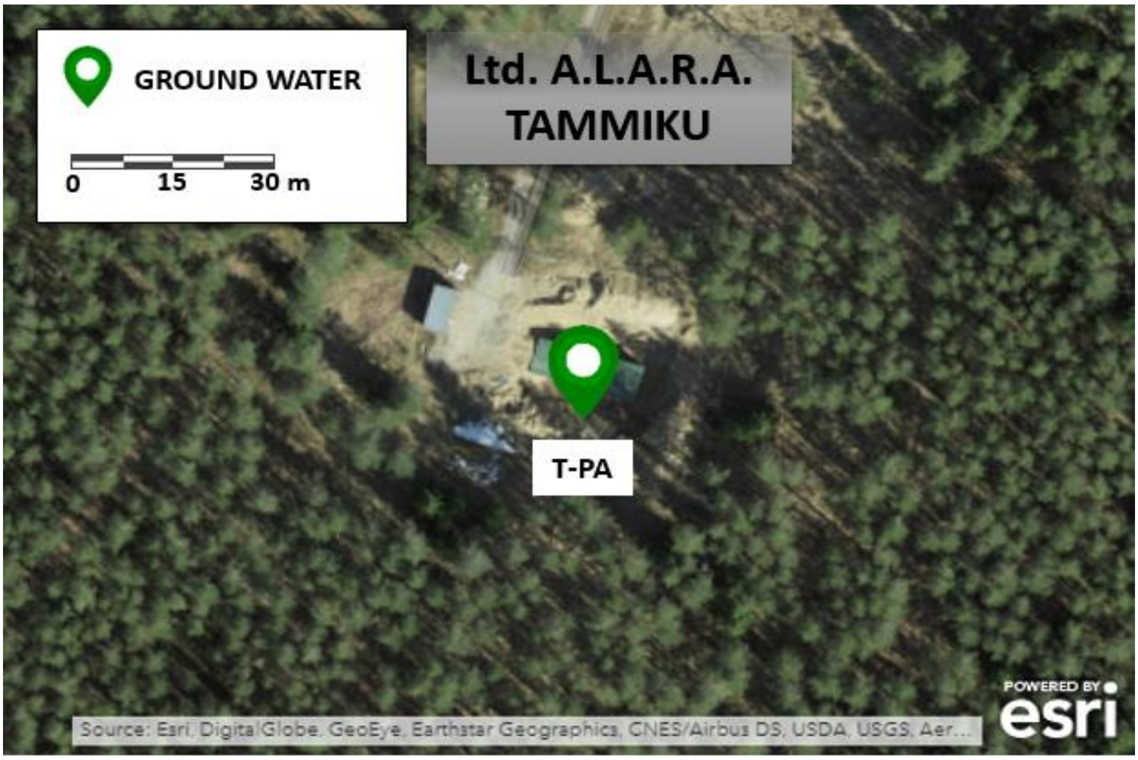

Figure 6. Water sampling location at the Tammiku site (A.L.A.R.A. Ltd.), located at Saku parish, Harju County

5.4.4 Drinking water

In the course of monitoring drinking water quality, the content of artificial radionuclides (^{137}Cs, ^{90}Sr and ^{3}H) in drinking water produced from surface water (from the surface water reservoir lake Ülemiste) and the natural radionuclides (^{228}Ra and ^{226}Ra) in drinking water produced from groundwater are determined semi-annually (Table VII). All drinking water samples are taken from the tap at the end user. There are two monitoring stations in Tallinn and one monitoring station outside Tallinn.

Artificial radionuclides are mainly found in surface water where they have been deposited. Thus, for the purposes of radioactivity monitoring, the drinking water which comes from surface water reservoir is chosen to characterize the largest consumer population in Tallinn. Drinking water samples are taken from the water tap of the Mustamäe district of Tallinn.

Artificial radionuclides normally do not enter groundwater, so the content of ^{137}Cs and ^{90}Sr is not measured in drinking water produced from groundwater. However, groundwater may contain naturally occurring radionuclides, in case of Estonia mainly Radium isotopes.

The content of Radium isotopes in different aquifers varies. Studies have shown that the activity concentrations of natural Radium isotopes are the highest in the Cambrian-Vendian aquifer. Cambrian-Vendian aquifer water samples are taken in north Estonia, where this layer is closest to the ground. Drinking water produced from the Cambrian-Vendian aquifer is measured according to the annual radiation monitoring programme. Respective drinking water samples are taken twice a year from the water tap of Sillamäe.

Drinking water can be produced also from raw water of different origins, i.e. water from different aquifers can be combined. Natural radionuclides in this type of drinking water are also monitored. For this purpose, twice a year drinking water samples are taken from the water tap of Tallinn's district of Nõmme.

Overview of the sampling sites is given in Table VII and Figure 7. In addition to the national monitoring programme, the individual drinking water suppliers need to monitor radioactivity, as required by the Directive 2013/51/Euratom[9].

Table VII. Drinking water monitoring stations

Monitoring station	Time of sampling	Samples annually	Amount of samples	Analysed nuclides, Measurement unit
SURFACE WATER				
Tallinn (Mustamäe)	February, October	2	30 litres per sample	^{137}Cs, ^{90}Sr, ^{3}H Bq/l
GROUND WATER				
Tallinn (Nõmme)	February, October	2	10 litres per sample	^{226}Ra, ^{228}Ra, ^{3}H Bq/l
Sillamäe	March, October			

9 Council Directive 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. (OJ L-296 of 07/11 2013, page 12)

Figure 7. Drinking water sampling locations

5.5 MONITORING OF SOIL AND SEDIMENTS

5.5.1 Soil

The purpose of soil sampling is to obtain information on the radioactive contamination deposited on the ground in different regions of Estonia, and to obtain information on the levels of naturally occurring radionuclides in the soil. The number of sampling locations annually varies from 2-4 (sampling in May – October). Monitoring frequency in each sampling location is once in 5 years.

Soil monitoring locations are presented on Figure 8. Samples are taken in a bare area that is free from human activity. A sample is taken from each vertex of an equilateral triangle (side length 1 m) to a depth of 20 cm and cut into layers of 5 cm. Samples collected from the same depth of all three samples are pooled and analysed. Activity concentrations of ^{137}Cs, ^{40}K, ^{226}Ra and ^{232}Th are measured.

5.5.2 Seabed sediments

The Baltic Sea and its surroundings were affected by the Chernobyl nuclear disaster, which resulted in an uneven distribution of radioactive contamination in the Baltic Sea area. Dispersion of pollution has been affected by river inflows, water mixing, currents and sedimentation. Most of the pollution is accumulated in sediments, so the marine environmental monitoring includes the analysis of seabed sediments, which are annually collected from two different locations (one sample a year) (Table VIII). From both monitoring locations, a sample is taken to a depth of 20 cm and sliced in 2 cm layers (10 layers). The sampling device is a Niemistö sediment sampler tube. Each layer is measured separately. Radioactivity concentrations of ^{137}Cs and ^{40}K are measured.

Seabed sediment samples are taken by the Tallinn University of Technology (Department of Marine Systems) according to an annual contract between the Environmental Board and the Tallinn University of Technology.

Table VIII. Seabed sediment sampling locations

Monitoring station	Coordinates		Number of samples per year	Analysed nuclides, Measurement unit
	North latitude	East longitude		
EE17	59° 43' 00"	25° 01' 00"	1 from each location	^{137}Cs, ^{40}K Bq/kg
23b	59° 18' 18"	23° 17' 18"		

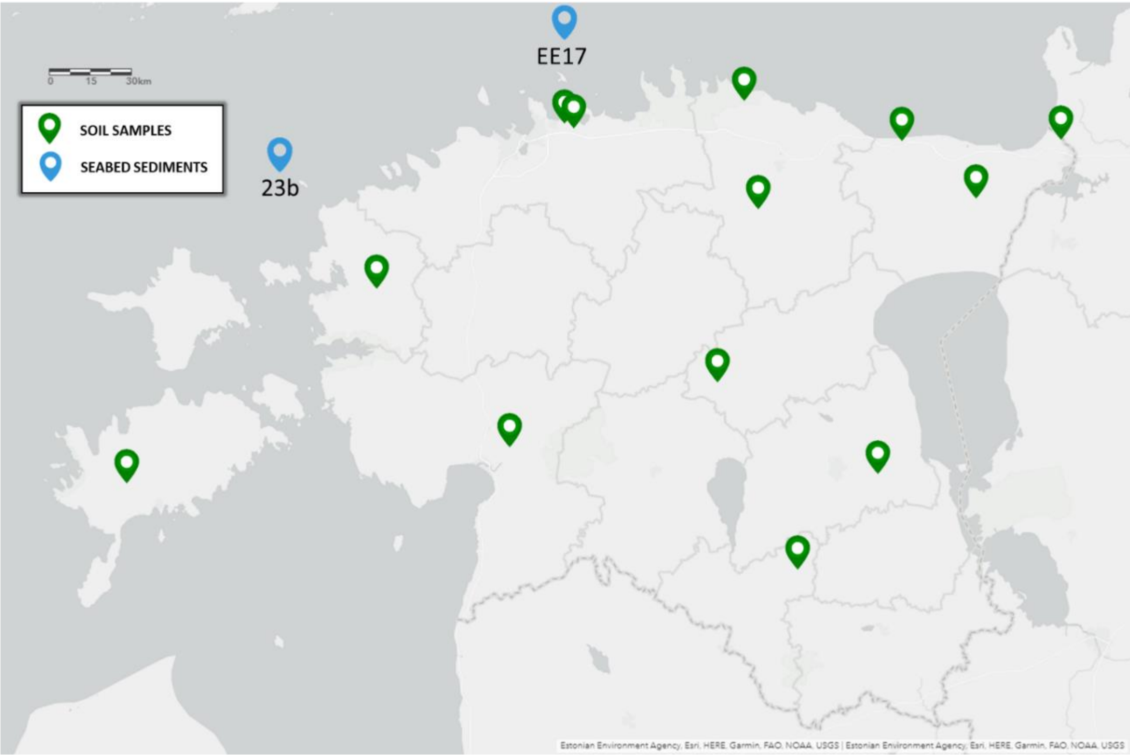

Figure 8. Soil and seabed sediment sampling locations

5.6 MONITORING OF TERRESTRIAL AND AQUATIC BIOTA

5.6.1 Sea plants

In the course of the marine radiation monitoring also sea plants are collected. The radioactivity concentrations of ^{137}Cs and ^{40}K are measured. The aim is to assess the level of radioactivity in the marine environment, including regional differences, and to monitor changes over time. From sea plants, bladder wrack is analysed and serves as an indicator for all sea plants. If there is no bladder wrack growing at the sampling point, algae washed ashore in the same area is sampled. Sampling areas include the Paldiski area and, in addition, depending on conditions, samples are collected from Kunda or Sillamäe (Figure 9). The amount of one sample is about 1.5 kg.

Sea plant samples are taken by the Tallinn University of Technology (Department of Marine Systems) according to an annual contract between the Environmental Board and the Tallinn University of Technology.

5.6.2 Mushrooms and berries

Wild mushrooms and berries are monitored for the levels of ^{137}Cs and ^{40}K (Figure 9). Samples are collected once a year from North-Eastern Estonia in the areas where most of the radionuclides were deposited after the Chernobyl accident. Monitoring of mushrooms and berries allows to estimate the amount of deposited radionuclides, to assess their contents in different species and to monitor changes over time and the radiation dose to humans caused by their consumption.

Each year samples are taken from the same sampling areas. Narva-Jõesuu sampling area is located in Narva-Jõesuu, Ida-Virumaa county, in the area between the Sininõmme cemetery, Kudruküla and Narva river. Kurtna sampling site is located in Alutaguse municipality around the lakes belonging to the Kurtna lakes area. Additional samples are taken from other regions of Northeast Estonia as needed; the locations and number of samples varies from year to year. Additional samples are taken when the number of samples from the designated sampling points is insufficient. This also allows for the collection of information on radioactivity levels in the natural environment of other regions and for the identification of regional differences.

As many different types of mushrooms and berries as possible are collected from each sampling site. In case of low yields, a sample of mixed mushrooms or berries is collected. The number of samples to be collected depends on the species present at the sampling site in different years. Collecting and analysing different species also provides information on how different species accumulate radionuclides from the soil.

Each year approximately 10 mushroom samples and 10 berry samples are analysed. The volume of one sample is about 1 litre. In addition, the content of radionuclides in forest mushrooms and berries growing in the vicinity of the A.L.A.R.A Ltd. sites in Paldiski and Saku municipalities is analysed (Figure 9).

5.6.3 Fish

In the marine radioactivity monitoring programme, the content of ^{137}Cs is monitored in marine fish (Figure 9). The aim is to assess the level of radioactivity in the marine environment, including regional differences, and to monitor changes over time. Baltic herring is analysed; if not available, a sample of another fish species is taken that has been caught from the same area. Fish samples are caught by the Tallinn University of Technology (Department of Marine Systems) according to annual contract between the Environmental Board and the Tallinn University of Technology. The amount of the one sample is about 1.5 kg.

Figure 9. Sampling sites of terrestrial and aquatic biota and fish

5.7 MONITORING OF FOOD AND FEED

5.7.1 Milk

Radiological monitoring of milk provides information on the radionuclide content of milk produced in Estonia. Milk is analysed by regions (counties) to observe regional differences in radionuclide content, which may provide information on the levels of radioactivity in the natural environment of the area. The aim is to periodically analyse raw milk produced in every county where there is dairy industry.

Milk is monitored for the content of artificial radionuclides (^{137}Cs, ^{90}Sr) and one natural nuclide (^{40}K) in raw milk samples (cow milk) collected within a county. Milk samples are collected once a month from the largest dairy in each monitored county. At the end of every quarter, monthly samples from the same county are combined into an average quarterly composite sample (1.5 litres) and analysed. Sampling points change over the years – milk samples from three different counties are examined each year. Monitoring frequency in each county is typically once in 2-3 years.

5.7.2 Mixed diet

Samples of a person's daily diet are monitored for the contents of artificial radionuclides (^{137}Cs and ^{90}Sr) and one natural radionuclide (^{40}K). Samples are taken twice a year from the kitchens of the biggest hospitals - Mustamäe building of the North Estonia Medical Centre (Tallinn) and the Tartu University Clinic (Tartu). A sample of a person's daily food is the amount of food that a person consumes in one day, including bread products and drinks. The examined sample represents the average food intake of the Estonian population, and thus the calculated radiation dose expresses the average internal radiation exposure obtained from food.

Since the daily diet samples may contain large amounts of local raw produce, the sampling points are chosen so that they are located in different regions of Estonia. The kitchens of the hospitals have been selected for sampling points as the food they serve represents typical food that an Estonian resident consumes daily.

5.7.3 Foodstuffs

The food monitoring programme measures the content of ^{137}Cs and ^{40}K in the most commonly consumed foods grown and produced in Estonia (Tables IX and X). It is different from monitoring a person's daily food as individual foods are analysed separately. This allows to estimate the radiation dose from the consumption of specific type of food. Additionally, the measurement results give information on the natural environment of the area where the food has been grown. The radioactivity of vegetables, cereals and meat is examined annually. In addition, a variety of food products such as eggs, dairy products, honey, baby food, etc. are sampled and analysed annually (Table X shows the example of the year 2020).

Samples are mainly taken from the commercial market, mostly in Tallinn. The amount of a sample is about 1.5 kg. The number of samples and the foods to be examined may vary from year to year. Sampling is normally based on the selection available. Vegetables are usually sampled in the autumn in order to have the vegetables of the current season. In case of vegetables, different types and/or varieties of vegetables are sampled and, where possible, samples are taken from vegetables that have grown in different regions of Estonia. Samples of grains are taken following the same principle. In meat sampling, primarily the meat from animals that are most commonly consumed (e.g. pork, beef, chicken, fish) is selected for analysis. The selection of additional food samples is based on the idea that they are important components of people's diet and that these foods (and their main ingredients) have grown in Estonia.

In addition to the annual fish samples collected by the Tallinn University of Technology, the Environmental Board also purchases fish from commercial sources, often from inland waters, especially from Lake Võrtsjärv, Lake Peipus (Figure 9) or from some other lake or bay (e.g. Pärnu Bay), around or inland Estonia.

Monitoring of imported food is not a part on the National Radiation Monitoring Program. Such analyses are carried out by the Veterinary and Food Board in co-operation with the Tax and Customs Board. Customs procedures include random physical checks, including laboratory analysis to determine the presence of ^{134}Cs and ^{137}Cs. Such analyses are carried out by the Laboratory of Agro-chemistry (Agricultural Research Centre).

All goods, which need further inspection, must be registered in a database called 'TRACES' 24 hours before coming through the Estonian border/customs. Goods coming from Japan require notification at least 48 hours prior.

Table IX. Radiation monitoring of commercial foodstuffs

Name of sample	Time of sampling	Samples annually	Sampling location	Analysed nuclides, Measurement unit
Foods of Estonian origin	All year round	~ 18	Commercial market	^{137}Cs, ^{40}K Bq/kg

Table X. Radiation monitoring of foodstuffs produced in Estonia (year 2020)

Name of sample	Time of sampling	Number of samples per year	Location of sampling
Vegetables (grown in different regions of Estonia)	August - September	8	Commercial network
Grains (grown in different regions of Estonia)	August - September	3	
Pork (animal grown in Estonia)	all year round	1	
Beef (animal grown in Estonia)	all year round	1	
Lamb (animal grown in Estonia)	all year round	1	
Poultry (bird grown in Estonia)	all year round	1	
Fish (caught in Estonian waters)	all year round	2	
Eggs	all year round	1	
Sour cream	all year round	1	
Baby food	all year round	1	
Fish	all year round	2	
Game (animal hunted in Estonia)	Hunting season	2	Commercial network or directly from hunters

5.7.4 Feeding stuffs

Feeding stuff monitoring is not done in a normal situation. It would be done following a nuclear accident or any other case of radiological emergency, which is likely to lead, or has led to, a significant radioactive contamination of food and feed. According to the National Emergency Response Plan, the Veterinary and Food Board is responsible, in cooperation with the Environmental Board, for arranging the monitoring of feeding stuff radioactivity.

5.8 EMERGENCY MONITORING

5.8.1 Introduction

In Estonia, the fire brigades have hand-held radiation dose rate monitors and the Rescue Board CBRN unit in Tallinn is equipped to carry out also contamination monitoring and nuclide identification. If widespread environmental monitoring is needed after an emergency situation, the Environmental Board has equipment for specialised radiological monitoring teams, which can be deployed anywhere in the country within a few hours.

5.8.2 Terrestrial monitoring

The Environmental Board has two separate mobile monitoring systems for terrestrial monitoring:

- **Mobile laboratory "Sonni" (Environics Oy)**

  The vehicle (Fig. 10) is designed to detect and analyse radiological and nuclear threats. The system includes stationary and mobile equipment. The vehicle is divided into three different sections: cockpit, operations area and storage area. It is designed to be operated with a crew of four.

  The laboratory is equipped with the following:

  - High-resolution gamma spectrometers
    - (Portable HPGe-based hand-held radioisotope identifier (ORTEC Detective DX-100)
    - 3 stationary built-in NaI(Tl) detectors (direction sensitivity is achieved with steel collimators)
    - Backpack RanidPro200 (Li-6 Neutron and $LaBr_3$ Gamma detector)
  - Air Sample Collection Systems
    - Two integrated intake tubes, sampling unit, measuring unit and pump unit (Mobile DWARF 100 sampling system, Senya Oy)
    - Two portable battery operated air samplers (JL-10-24 Lilliput, Senya Oy)
  - Other hand-held monitoring equipment as needed for the task
  - Internal network (server, database and workstations with laptops)
  - Uninterruptible Power Supply (UPS)
  - GPS receiver

- **SPIR-Ident Mobile Advanced Spectroscopy Platform (manufactured by Mirion Technologies)**

  The system (Fig. 11) utilizes two large advanced gamma spectroscopic NaI(Tl) detectors. It delivers fast and reliable detection and real-time nuclide identification capabilities. The system can be used for terrestrial, marine or airborne monitoring. The system was purchased in July 2020.

In addition, the Environmental Board also has several backpack monitoring systems, hand held dosimeters, radiation identifiers and contamination monitors (Figure 12).

Figure 10. Mobile radiation laboratory ‘Sonni’

Figure 11. SPIR-Ident Mobile Advanced Spectroscopy system

Figure 12. Hand-held monitoring equipment of the Environmental Board

5.8.3 Airborne monitoring

The Estonian authorities have no capabilities to carry out airborne radioactivity monitoring on the Estonian territory. The SPIR-Ident system can be used in a helicopter, but there are no established procedures for such operation.

5.8.4 Civil protection services monitoring

The Estonian Rescue Board operates a CBRN unit, which is capable of monitoring radiation dose rate and surface contamination, and which can carry out basic nuclide identification and radioactive source recovery operations. The unit is available on a 24/7 basis. It is based in Tallinn; it can reach any location is Estonia within a few hours.

5.9 INFORMATION FOR THE GENERAL PUBLIC

The Environmental Board publishes annual monitoring reports every year in March at the Environmental Board official website. The site also includes the following periodically uploaded information from the Early Warning System[10]:

- Information from the automatic gamma dose rate monitoring stations (graphics and tables). The same information is also provided as online EURDEP widget in order to make it easily accessible to the members of the public. The widget is translated into Estonian language.

[10] https://www.keskkonnaamet.ee/et/eesmargid-tegevused/kriisireguleerimine/varajane-hoiatamine

- Analysis results from aerosol stations – mostly ^{137}Cs and ^{7}Be results. The data is updated once a month.

In case of further interest, the information may also be presented as news or press releases. Environmental Board also uses a Facebook account to share operational information.

The Environmental Board delivers an annual monitoring report to the Environment Agency, which gathers all environmental monitoring data collected under the different environmental monitoring subprograms from various national bodies and universities, and makes it available to the public on their webpage. The Environment Agency maintains the National Environmental Monitoring Database KESE[11]. At this site, the members of the public can search for information about different sampling results from different environmental spheres or monitoring programs. Currently the database includes some radiation monitoring data, but not all of it (the database is new and still under development).

The Environment Agency also composes publications (electronic and paper) about overviews of the environmental conditions (including radioactivity) in cooperation with the responsible organizations[12] for the monitoring. It also arranges annual public events to introduce different monitoring programs, developments, monitoring results, etc.

The monitoring reports of the post-monitoring program of the Sillamäe tailings pond are published at the Environment Agency's official webpage semi-annually. The Ministry of the Environment organises annually public events called "Radiation Days" to introduce all kind of developments and news in the field of radiation protection and safety, incl. radiation monitoring.

6 ANALYTICAL LABORATORIES

6.1 LABORATORY OF THE ENVIRONMENTAL BOARD

6.1.1 Introduction

The laboratory of the Environmental Board (Radiation Safety Department) is responsible for analyses of the following environmental samples:

- Airborne particles
- River water
- Drinking water
- Milk
- Daily diet
- Foodstuffs (vegetables, meat, grains, baby food, milk products, fish, grains, etc.)
- Marine samples (seawater, fish, aquatic plants, sediments)
- Wild mushrooms and berries
- Wild game
- Soil
- Samples from areas near radiation legacy sites (well water, mushrooms, berries)

Sampling of milk is done by the Veterinary and Food Board and sampling of marine environment by the Tallinn Technical University (Department of Marine Systems). Collection of air filters is done by the Environment Agency or the Estonian Police and Border Guard Board.

All the analyses under the National Radiation Monitoring Program are performed in this laboratory. The laboratory offers analytical services also on commercial basis.

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11 https://kese.envir.ee

12 https://www.keskkonnaagentuur.ee/et/keskkonnaseirevaljaanded

6.1.2 Sample preparation and counting

Samples are registered by the sampler on an excel spreadsheet, where the associated monitoring data are recorded (sampling place, sampling date, etc.). At the laboratory, the samples are registered at the laboratory registration system (Excel sheet with sample name, arrival date at the laboratory, identification code, etc.).

The following sample preparation and counting procedures are used:

- **Airborne particles**

The whole air filter (glass microfiber filter) is pressed to a specific shape using a hydraulic press and analysed by gamma spectroscopy.

- **River water**

For water samples of initial volume 30 l, CsCl is added as carrier, and samples are acidified to pH 1-2 by using nitric acid. The fresh and seawater samples are then evaporated to 1000 ml and analysed by gamma spectroscopy.

- **Drinking water**

Determination of gamma nuclides

For surface water samples of initial volume 30 l, CsCl is added as carrier, and samples are acidified to pH 1-2 by using nitric acid. The water samples are then evaporated to 1000 ml and analysed by gamma spectroscopy.

Determination of ^{90}Sr

Water samples of initial volume 8 l. The samples are evaporated to dryness. Determination of ^{90}Sr (^{90}Y) by HDEHP-extraction of ^{90}Y and counting the Cerenkov radiation in a liquid scintillation counter.

Determination of ^{226}Ra

Water samples of initial volume 1 l. Isolation of radium from the sample solution by co-precipitation with lead sulphate. The precipitate is dissolved in alkaline DTPA. The radium isotopes are separated from other radionuclides by co-precipitation with barium sulphate. The barium/radium precipitate is dissolved in alkaline EDTA. The solution is transferred to a liquid scintillation vial and the scintillation cocktail is added. The sample is left until equilibrium between ^{226}Ra and ^{222}Rn is established. Measured by liquid scintillation counting.

Determination of ^{228}Ra

Water samples of initial volume 5 l. Isolation of radium from the sample solution by co-precipitation with lead sulphate. Filtration; the filter with the precipitate is measured by gamma spectrometry.

Determination of ^{3}H

Water samples of initial volume 100 ml. Distillation of water sample, 8 ml of water sample is transferred to a liquid scintillation vial and liquid scintillation cocktail is added. Measured by liquid scintillation counting.

- **Milk**

Determination of gamma nuclides

Direct gamma spectroscopy of a 1 l milk sample.

Determination of ^{90}Sr

Milk samples of initial volume 0.5-1 l. Determination of ^{90}Sr(=^{90}Y) by HDEHP-extraction of ^{90}Y and counting the Cerenkov radiation in a liquid scintillation counter.

- **Daily diet**

Determination of gamma nuclides

Solid food with drinks. Drying and ashing (450ºC) the sample. Analysed by gamma spectroscopy.

Determination of ^{90}Sr

Determination of ^{90}Sr(=^{90}Y) by HDEHP-extraction of ^{90}Y and counting the Cerenkov radiation in a liquid scintillation counter. Food samples are oven dried and ashed. The ash is dissolved in 1 molar hydrochloric acid and at pH 1.0-1.2 the ^{90}Y is extracted from the solution with 10% HDEHP. ^{90}Y is back extracted into 3 molar nitric acid and precipitated as hydroxide. The hydroxide precipitation is dissolved in 1 ml conc. nitric acid.

- **Foodstuffs (vegetables, meat, grains, baby food, milk products, fish, grains, etc.)**

Direct gamma spectroscopy of 0.5-1.5 kg of sample.

- **Seawater**

For water samples of initial volume 50 l, CsCl is added as carrier, and samples are acidified to pH 1-2 by using nitric acid. The fresh and seawater samples are then evaporated to 1000 ml and analysed by direct gamma spectroscopy.

- **Sea fish**

1-2 kg of fish sample. Drying and ashing (450 ºC) the sample. Direct gamma spectroscopy.

- **Aquatic plants**

1-2 kg of plants sample. Drying and ashing (450 ºC) the sample. Direct gamma spectroscopy.

- **Sediments**

Drying (105 ºC) the sample. Direct gamma spectroscopy.

- **Wild mushrooms and berries**

Direct gamma spectroscopy of a 0.5-1.5 kg of sample.

- **Wild game**

Direct gamma spectroscopy of a 0.5-1.5 kg of sample. Measured radionuclides ^{137}Cs and ^{40}K (Bq/kg).

- **Soil**

Drying (105 ºC) the sample. Direct gamma spectroscopy. Measured radionuclides ^{137}Cs, ^{40}K, ^{226}Ra, ^{232}Th (Bq/kg).

- **Well water**

Determination of ^{3}H

Water samples of initial volume 100 ml. Distillation of water sample, 8 ml of water sample is transferred to a liquid scintillation vial and liquid scintillation cocktail is added. Measured by liquid scintillation counting.

6.1.3 Counting equipment

The laboratory has the following counting equipment:

Gamma-spectrometers

- 4 devices with Canberra HPGe detectors
- Efficiency calibration with LabSOCS software
- Energy calibration with multinuclide standards
- Calculations software: Genie 2000 and Apex

Liquid scintillation counters

- 2 devices (one device is routinely used, the other (older) is a backup)
- Manufacturer: PerkinElmer, Wallac (older)
- Calibration with standard solutions
- Calculations software: WinQ, Easy View

6.1.4 Data handling

The measurement results are recorded and saved in the form of spectrums and reports in the control computers of the devices. Printouts of the protocols are stored and archived according to the Environmental Board requirements. The measurement results are recorded on an Excel spreadsheet, where the measurement result is presented together with the measurement uncertainty or measurement MDA.

According to the regulation of the Ministry of the Environment (*Requirements and procedure for the implementation of the national environmental monitoring program and sub-programs*), the responsible executor of the radiation monitoring sub-program shall submit the environmental monitoring data collected during the monitoring year to the Environment Agency and the Ministry of the Environment as a report by 1. March of the calendar year following the monitoring year.

All the dose rate and air radioactivity concentration data are submitted in real time to the EURDEP database.

The Radiation Safety Department inserts monitoring results to the REM database once in a year, no later than 30. June. Once a year all the marine monitoring data are submitted to the HELCOM database.

6.1.5 Accreditations

The Environmental Board laboratory is accredited according to ISO/IEC 17025:2017 in the field of gamma spectrometry measurements, including ^{228}Ra in water.

The laboratory regularly participates intercomparison exercises and proficiency tests. A list of these exercises is in Annex 2.

6.2 LABORATORY OF THE ÖKOSIL LTD

Ökosil Ltd is a company founded by the Republic of Estonia and the Silmet Grupp Ltd with the purpose of managing large environmental projects (for example, Ökosil Ltd manages the Sillamäe Radioactive Tailings Pond Remediation), and to provide other environmental management and monitoring related services.

The Sillamäe uranium mining tailings pond has been remediated. The remediation works took place from 1998 to 2008. Now this is a green area, which is under a post-monitoring program. The purpose of the post-monitoring is to assess the effectiveness of the remediation and to assess the environment and tailings pond physical conditions. To enhance public confidence the program also includes environmental radiation monitoring. Under annual contracts with the Ministry of the Environment, the Ökosil Ltd organises radiation monitoring at the re-vegetated tailings pond area. Monitoring is funded from the state budget (Ministry of the Environment). According to the contract, Ökosil Ltd has to submit a monitoring report to the Ministry of the Environment twice a year.

The laboratory of the Ökosil Ltd is located in Sillamäe. It is accredited by the Estonian Centre of Accreditation. The accreditation includes the following: sampling, field measurements, laboratory analysis (surface-, ground- and wastewater; ambient air and gaseous emissions), and radiation monitoring (alpha-, beta- and gamma radiation, aerosols and Radon).

The laboratory provides radioactivity analyses to the NORM industry company NPM Silmet. NPM Silmet is a producer of high purity Niobium and Tantalum metals. Requirements for the monitoring come from the radiation practice license of the NPM Silmet.

6.3 Laboratory of Nuclear Spectroscopy, Testing Centre of the University of Tartu

The Laboratory of Nuclear Spectroscopy under the Testing Centre of the University of Tartu conducts national research projects and offers laboratory analysis services to the clients. It is located in Tartu. It has an accreditation in gamma spectrometry for measuring Radium isotopes in water.

The research is focused on the following topics:

- Environmental radioactivity in Estonia for obtaining information about transport and migration of natural and artificial radionuclides in soil, air and water, as well as radio-ecological pathways of radionuclides and the formation of irradiation dose in radioactive waste management and impact sources from energy production;
- Development and implementation of gamma spectrometry and methods for numerical modelling, including low-energy high-purity Germanium (HPGe) gamma-spectrometry;
- Validating quality measures for quantitative analysis of environmental samples through routine international proficiency tests, transport models of radionuclides and radio-ecological models of radionuclide pathways in the air, water and soil, gamma-radiation resonance forward-scattering models of ultra-fine interactions;
- Development of analysis methods for alpha- and beta-radiation detection in environmental applications.

6.4 Laboratory of Agro-chemistry

The Laboratory of Agro-chemistry is a laboratory under the Agricultural Research Center. It is a state agency supporting agriculture and rural development. It is managed by the Ministry of Rural Affairs, which unites various laboratories, as well as departments dealing with agri-environmental monitoring, rural economic analysis and rural networking.

The laboratory is located in Saku. It carries out radiological analyses of the imported food samples collected by the Veterinary and Food Board.

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 ENVIRONMENTAL BOARD

The verification team visited the Estonian Environmental Board (EB)[13]. The EB demonstrated to the verification team the mobile monitoring equipment used for emergency preparedness and presented the automatic network for gamma dose rate monitoring. The verification team visited also the EB radio-analytical laboratory.

7.2.1 Mobile laboratory

The EB mobile laboratory (Fig. 10) is a custom-built Mercedes-Benz van equipped with air sampling systems and three NaI(Tl) detectors for carrying our terrestrial radiation surveys by dose rate mapping and sample analysis. The van has a UPS system and an electrical power aggregate for independent operation.

The air sampling systems in the mobile laboratory are equipped with particle filters; there is no possibility to equip them with charcoal cartridges for gaseous iodine monitoring.[14]

> *Verification team suggests creating a mobile capability to monitor gaseous radioactive iodine in the event of an emergency.*

7.2.2 Mobile monitoring equipment

The EB possesses and operates a large collection of portable monitoring equipment (Fig. 12), including the following:

- One portable radiation detection system (Mirion SPIR-Ident), consisting of 2 high sensitivity 4 liters NaI(Tl) detectors and a GM-tube. Detectors can be user separately. System is designed to carry out terrestrial, marine or airborne monitoring and produce contamination maps.
- Three terrestrial monitoring backpacks with NaI(Tl) detectors, GM-tubes and neutron detectors.
- Portable HPGe gamma spectroscopy system (electrically cooled Ortec Detective DX-100™)
- Portable NaI(Tl) gamma spectroscopy system (Canberra Inspector 1000™)
- Portable $LaBr_3$(Ce) gamma spectroscopy system (Mirion SPIR-Ace™)

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13 Kopli 76, Tallinn

14 Charcoal cartridges are available for the fixed high-volume air samplers.

- Portable nuclide identification devices (FieldSpec and IdentiFINDER)
- Portable air samplers (Lilliput)
- Hand-held contamination monitors
- Hand-held dose rate meters
- Hand-held neutron monitors
- Personal dosimeters

The verification team was informed that most of the staff who work at the Radiation Safety Department can use the simpler measuring devices; however, it is acknowledged that more regular training should be provided on the use of the more complex devices, in order to increase the number of users who can use these, especially during an emergency.

No remarks.

7.2.3 Radio-analytical laboratory

The EB laboratory facility has been refurbished in 2015; there is sufficient room for all the analytical functions. The laboratory has accreditation (valid until 2025) for gamma spectroscopy and determination of ^{228}Ra in water; it participates in intercomparison exercises annually (Annex 2).

Sample management is based on Excel-sheets; the laboratory does not have a dedicated information system for managing samples and measurement results.

The sample preparation rooms are well equipped with dryers (4), furnaces (6) and freezers. Temperature control of the furnaces used for sample ashing is certified by an outside service on an annual basis.

The laboratory counting equipment is the following:

- Four HPGe gamma spectrometers with Genie 2000 analysis software. Detectors have been characterised for mathematical calibration. Calibration of the system is based on calibration software LabSocs but also standard sources are available. Three HPGe detectors are liquid nitrogen cooled; one has a combined liquid nitrogen-electrical cooling system.
- Two liquid scintillation counters (a Quantulus 1220 and an old Wallac). The Wallac system is not a sufficient back-up for the Quantulus, but additional counting capacity is available at the University of Tartu.

Regular quality controls (resolution, stability) and background measurements are performed and documented on each detector. The laboratory has no capacity to perform alpha spectroscopy; total alpha/beta counting is available from water by liquid scintillation counting.

The verification team was informed, that in the event of an emergency, the laboratory plans to use the garage as a dedicated storage area for incoming samples, but apart from that, there is no documented procedure for sample management in a situation where the number and activity level of the incoming samples significantly increase.

The verification team suggests that a LIMS system is implemented at the Environment Board laboratory.

The verification team suggests that the EB laboratory puts in place a documented procedure for the management of a large number of incoming (contaminated) samples in the event of an emergency.

The verification team commends the use of an external calibration service for the furnace temperature control.

7.2.4 Air sampling in Harku

The verification team visited the high-volume air sampler in Harku. This SnowWhite JL-900 collector has been in 24h operation since 2014. Collection volume is stabilised to about 480 m^3/h (compensated airflow). The station is located in a fenced meteorological instrument garden. The staff of the meteorological station changes the filter on weekly basis. The system has no electrical back-up.

The SnowWhite high-volume air samplers can be equipped with charcoal cartridges for monitoring gaseous radioactive iodine, but there is no established procedure at the EB for this type of monitoring.

> *The verification team recommends that the EB makes sure there are charcoal cartridges available for monitoring gaseous iodine, and a documented procedure is available for their use and analysis in the event of an emergency.*

7.2.5 Dose rate monitoring in Tallinn

The verification team visited the station number EE20395 of the automatic dose rate monitoring network in North-Tallinn. This station is located at the roof of the Environment Board office entrance building at about four meters height. It is the only station of the 15 stations of the automatic radiation monitoring network, which is located in Tallinn.

> *No remarks.*

7.2.6 Automatic radiation monitoring network

A demonstration of the remote user interface of the automatic radiation monitoring network was provided to the verification team. The web-based system presents a geographical display of the radiation situation in Estonia and the technical status of each monitoring station. In addition, it is possible to display the NaI(Tl) spectrum (10 minutes, 1 and 24 hour) of each detector and to carry our remote maintenance of the stations.

There are 15 stations distributed evenly across the Estonian territory. Only one station is located in Tallinn. Taking into account the large population and geographical area in Tallinn, a second station would provide improvement in monitoring reliability.

The system alerts the EB duty officer in the event of high values or technical problems; the dose rate alarm threshold is set individually for each station.

The dose rate readings are sent to the EURDEP system and made available at the EB website using the EURDEP widget. This is not a preferred solution – the EURDEP system should not be the primary pathway for providing information to the public; a more reliable option would be to transfer data directly from the monitoring system to the public website and use the EURDEP widget in parallel to present results from a larger geographical area.

> *The verification team suggests that the dose rate data be transferred to the public website directly, not via the EURDEP system widget.*

> *The verification team suggests installing an additional automatic dose rate monitoring station in the Tallinn city area.*

7.3 INFORMATION TECHNOLOGY CENTRE OF THE MINISTRY OF THE ENVIRONMENT

The verification team visited the Information Technology Centre of the Ministry of the Environment (KeMIT)[15], which maintains the environmental databases and the data servers of the monitoring networks. The centre has been operational since 2013. It maintains the automatic radiation monitoring network data servers and has a support contract with Envinet for their maintenance.

15 Teaduspargi 8, 12618 Tallinn

The network servers are located in a high-security server room. In the event of data transmission or electrical power problems, the monitoring stations switch to battery operation and store their data locally. Battery operation can continue up to 7 days.

No remarks.

7.4 ESTONIAN RESCUE BOARD

The verification team verified the radiation monitoring equipment of the Estonian Rescue Board CBRN unit[16]. This unit is the only CBRN unit in Estonia. It is equipped with the following radiation monitoring equipment:

- Electronic dose monitors far each staff member
- TLD dosimeters for each staff member
- Alpha/beta/gamma survey meters for contamination detection
- Hand-held dose rate monitors
- Nuclide identification system

In addition, the unit has ^{137}Cs test sources and small shielded containers for radiation source recovery.

The verification team was informed that the normal fire brigade units in Estonia typically have radiation dose rate monitors, but no other radiation monitoring equipment.

No remarks.

7.5 UNIVERSITY OF TARTU

The verification team visited the Laboratory of Nuclear Spectroscopy of the Testing Centre of the University of Tartu[17]. The laboratory carries out research on Ra-activity on the Estonian ground water. Due to specific geological conditions, the Ra-activity can lead to elevated radiation doses received by the users of deep ground water (typically customers of public water companies), even to doses exceeding the indicative dose parametric value (0.1 mSv annual dose) of Directive 2013/51/Euratom.

The laboratory is accredited to determine Ra in water. It analyses about 70 water samples each year. In addition, there was a contract with the Estonian Health Board for additional 110 samples in 2012-2014. Sample management is based on Excel-sheets; the laboratory has no dedicated sample and results management system.

Laboratory research activity includes also gamma spectroscopy of solid materials (sand, gravel and soil). Research is done also on radium activity in water treatment plant filtrates.

The laboratory counting equipment includes three gamma spectroscopy systems, an alpha spectroscopy system, two liquid scintillation counters and a radon monitor. The gamma spectroscopy analysis system (Ortec 92X) is old, but functional.

The verification team suggests renewal of the gamma spectroscopy systems' electronics and counting software in the near future.

The verification team commends the unique research activity on ^{228}Ra in ground water.

[16] Erika 3, Tallinn

[17] Ravila 14C, 50411 Tartu

7.6 Follow-up of the 2010 recommendations

The verification team reviewed the recommendations issued during the previous verification in 2010[18]. The Estonian competent authority has reported on the implementation of the 2010 recommendations in 2012[19]. Table XI below summarises the recommendations and their follow-up.

Table XI. Follow-up to the 2010 recommendations

Recommendation 2010	Follow-up 2020
Environmental Board laboratory	
The verification team supports the on-going work towards accreditation of other laboratory analysis methods and acknowledges the extent of the intercomparison exercise activity.	***Completed.*** *The main analytical methods have been accredited.*
The verification team recommends that the gamma-spectroscopy hardware be developed towards a more harmonised system, which would allow for greater flexibility in the measurement operations and would ensure sufficient measurement capacity also for emergency situations.	***Completed****. The new gamma spectroscopy hardware is sufficient and harmonised.*
Automatic radiation monitoring network	
The verification team supports the planned modernisation of the system data centre, especially the creation of a user-friendly graphical data display.	***Completed.*** *The system data centre has been modernised and a new graphical display is available.*
Mobile monitoring	
The verification team suggests making sure that there is enough trained staff to operate the mobile and hand-held instruments in case of emergency. In addition, in order to restore mobile measurement operations capability, the team recommends repairing the detector mounted on the vehicle as soon as possible.	***Partially completed****. The mobile monitoring equipment has been modernised, but there may still be lack of trained staff to carry out the monitoring in an emergency situation.*
Harku air sampler	
The verification team supports the efforts to equip the station with an airflow meter.	***Completed****. The air sampler in Harku has been modernised.*
Pärnu and Narva-Jõesuu	
The verification team notes that the monitoring equipment is getting old and therefore should be renewed in a near future.	***Completed****. The air samplers have been modernised at both sites.*

18 Verifications under Article 35 of the Euratom Treaty, Technical report EE-10/04, 2010 (https://ec.europa.eu/energy/sites/ener/files/documents/tech_report_estonia_2010_en.pdf)

19 Verification follow-up report of the Estonian authorities 2012 (https://ec.europa.eu/energy/sites/ener/files/documents/response_estonia_2010.pdf)

Recommendation 2010	Follow-up 2020
Sillamäe *The verification team points out that the Sillamäe site requires long-term radiological surveillance. In order to ensure a continuous and credible monitoring programme also in the future the responsibilities need to be defined very clearly and sufficient resources need to be allocated for the monitoring programme.*	***Completed**. Verification team was informed* that there is a long-term programme and sufficient resources for the environmental monitoring of the Sillamäe site are available.* *(*Sillamäe was not included in the 2020 verification.)*

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 very useful.

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

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

(4) The recommendations provided by the Commission in 2010 have been implemented to a satisfactory degree.

(5) A few recommendations and suggestions have been formulated. They concern in particular monitoring of gaseous radioactive iodine and laboratory management in the event of an emergency. Notwithstanding these recommendations, the verified parts of the monitoring system for environmental radioactivity in Tallinn are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

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

(7) The Commission services kindly request the Estonian authorities to submit, before the end of 2022, a progress report on how the team's recommendations have been implemented, and on any significant changes in the set-up of the monitoring systems. Based on this report the Commission will consider the need for a follow-up verification in Estonia.

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

ANNEX 1

VERIFICATION PROGRAMME

EURATOM ARTICLE 35 VERIFICATION ESTONIA (TALLINN)

23 - 25 SEPTEMBER 2020

<u>Wednesday 23 September</u>

10:00 **Opening meeting**

(Environmental Board, Radiation Safety Department, Kopli 76, 10416 Tallinn)

- European Commission Art. 35 verification programme introduction
- Discussion on the past verifications in Estonia by the Commission
- Overview of radioactivity monitoring arrangements in Estonia
- Verification planning

11:00 **Radioactivity monitoring arrangements in Estonia and Tallinn**

- Dose and dose rate monitoring
- Air sampling
- Soil sampling
- Water sampling
- Food sampling
- Mobile monitoring systems
- Emergency monitoring systems
- Public information arrangements

14:00 **Verification of selected monitoring facilities in Tallinn and surroundings**

- Portable monitors (Environmental Board office)
- Automatic radiation monitoring station (Environmental Board office)
- High-volume air sampler (Harku)
- Monitoring network data centre (Information Technology Centre of the Ministry of the Environment)

17:00 Close

Thursday 24 September

09:00 **Verification of radioactivity monitoring laboratories in Estonia**

Laboratory of the Environmental Board, Radiation Safety Department,

(Environmental Board, Radiation Safety Department, Kopli 76, 10416 Tallinn)

- Introduction to the analytical programme
- Laboratory facilities

14:00 **Verification of emergency radioactivity monitoring facilities**

(Environmental Board, Radiation Safety Department, Kopli 76, 10416 Tallinn)

- Mobile radiation laboratories

15:00 **Verification of the civil protection mobile emergency monitoring systems**
(Rescue Board, Erika 3, Tallinn)

- Emergency monitoring equipment

17:00 Close

Friday 25 September

09:00 **Verification of radioactivity monitoring laboratories in Estonia**

Laboratory of Nuclear Spectroscopy, Testing Centre of University of Tartu

(University of Tartu, Ravila 14C, 50411 Tartu)

- Introduction to the analytical programme
- Laboratory facilities

15:00 **Closing meeting**

(Environmental Board, Radiation Safety Department, Kopli 76, 10416 Tallinn)

16:00 Close

ANNEX 2

ENVIRONMENTAL BOARD LABORATORY

PARTICIPATION IN INTERCOMPARISON EXERCISES AND PROFICIENCY TESTS

Year	Intercomparison / PT	Matrix	Samples	To analyse
2009	STUK-Intercomparison on determination of Rn-222 concentration from drilled well water	Well water	1	Rn-222
2009	IAEA-CU-2008-04 ALMERA proficiency test on the determination of natural radionuclides in phosphogypsum and spiked Water	Phosphogypsum	1	Ra-226
		Spiked water	2	Ra-226
		Spiked water	3	∑ α ja β
2010	IAEA-2009-03 world wide open proficiency test on the determination of natural and artificial radionuclides in moss-soil and spiked water	Moss-soil	1	Cs-137, K-40, Ra-226
		Spiked water	3	Cs-134, Cs-137, Eu-152, Co-57, Co-60
2010	EC interlaboratory comparison on natural radioactivity, Cs-137, Sr-90	Soil	1	K-40, Cs-137, Th-232, Ra-226, Sr-90
2010	HELCOM-MORS Seawater Intercomparison	Seawater	1	Cs-137
2011	IAEA-2010-03 world wide open proficiency test on the determination of natural radionuclides in Water and Ra-226 in soil	Water	2	∑ α ja β
		Water	3	Ra-226
		Soil	1	Ra-226
2011	EC interlaboratory comparison on Sr-90, Cs-137, K-40 activity content in wild bilberry Powder	Bilberry powder	1	Sr-90, Cs-137, K-40
2011	HELCOM-MORS Seawater Intercomparison	Seawater	1	Cs-137
2011	IAEA-TEL-2011-04 ALMERA Proficiency test on the determination of Radionuclides in soil and water	Water	3	Cs-137, Cs-134, Co-60, Ba-133, Eu-152, Am-241, H-3
		Soil	1	Cs-137, K-40, Ra-226, Sr-90
2012	HELCOM-MORS Seawater Intercomparison	Seawater	1	Cs-137
2012	EC Interlaboratory Comparison on gross alpha/beta activity in drinking waters	Water	3	∑ α ja β
2012	IAEA-TEL-2012-04 ALMERA Proficiency test on the determination of Radionuclides in water, hay and soil	Water	2	Cs-137, Cs-134, Am-241, Eu-152
		Hay	1	Cs-137, Cs-134

Year	Intercomparison / PT	Matrix	Samples	To analyse
		Soil	1	Cs-137, K-40
2013	HELCOM-MORS Seawater Intercomparison	Seawater	1	Cs-137
2013	IAEA-TEL-2013-04 ALMERA Proficiency test on the determination of Radionuclides in water and flour	Water	2	Cs-137, Cs-134, Am-241, Eu-152, Co-60
		Flour	1	Cs-137, Cs-134
2013	IAEA-RCA-RAS/7/021 Proficiency Test for Sr-90, Cs-134 and Cs-137 Determination in Seawater	Seawater	1	Cs-137, Cs-134
2014	IAEA Proficiency Test for Sr-90, Cs-134 and Cs-137 Determination in Seawater	Seawater	1	Cs-137, Cs-134
2014	IAEA-TEL-2013-04 ALMERA Proficiency test on the determination of Radionuclides in water, seaweed and sediment samples	Water	3	Cs-137, Cs-134, Sr-90 Am-241, Eu-152
		Seaweed	1	Cs-137, Cs-134
		Sediments	1	Cs-137
		Water	1	Ra-226
2015	IAEA-TEL-2014-04 ALMERA Proficiency test on the determination of Radionuclides in water, Brown Rice and soil samples	Water	3	Cs-137, Cs-134, Sr-90, Na-22, Zn-65
		Rice	1	Cs-137, Cs-134, K-40
		Soil	1	Cs-137
2015	IAEA Proficiency Test for Sr-90, H-3, Cs-134 and Cs-137 Determination in Seawater	Seawater	1	Cs-137, Cs-134, H-3
2015	EC Interlaboratory Comparison on Cs-137 in air filters	Air filter	1	Cs-137
2015	HELCOM MORS Seawater	Seawater	1	Cs-137
2016	HELCOM MORS Seawater	Seawater	1	Cs-137
2016	EC Interlaboratory Comparison Cs-137, Cs-134 and I-131 Measurement in air filters	Air filter	1	Cs-137, Cs-134, I-131
2016	IAEA ALMERA PT IAEA-TEL-2016-04	Water	2	$\sum \alpha$ ja β Cs-137, Cs-134, Na-22, Sr-90, Am-241, Mn-54, Zn-65, Am-241
		Spruce needles	1	K-40, Cs-137, Sr-90
		Sediment	1	Ra-226
2016	Proficiency Test for Tritium, Strontium and Caesium Isotopes in Seawater 2016 (IAEA-RML-2016-01)	Seawater	1	Cs-137, Cs-134
2016	Võrdlusmõõtmine Keskkonnaameti kiirgusseire büroo labori ja TÜ FI vahel	Drinkingwater	1	Ra-226, Ra-228
2016-2017	IAEA-PT Determination of Low Activity Radio-Caesium in Freshwater,	River water	3	Cs-137, Cs-134
2017	EC Proficiency Test on I-131,134Cs, and 137Cs activity measurements in maize powder	Maize powder	1	Cs-137, Cs-134, I-131, K-40

Year	Intercomparison / PT	Matrix	Samples	To analyse
2017	ConvEx-3-2017 exercise	Water	1	Ba-133, Cs-134, Cs-137
2017	IAEA-TEL-2017-04 ALMERA proficiency test on determination of anthropogenic radionuclides in water, milk powder, Ca-carbonate	Water	3	∑ α ja β, H-3, Sr-90, Ba-133, Cs-137, Ba-140, I-131, Ce-141, La-140, Mo-99, Nb-95, Nd-147, Np-239, Ru-103, Te-132, Zr-95
		Milk powder	1	Ba-133, Cs-137, K-40
		Ca-carbonate	1	Ra-226, Ra-228
2017	Proficiency Test for Tritium, Cobalt, Strontium and Caesium Isotopes in Seawater 2017 (IAEA-RML-2017-01)	Seawater	1	Cs-137, Cs-134, Co-60
2017	HELCOM MORS Seawater	Seawater	1	Cs-137
2018	HELCOM MORS Seawater	Seawater	1	Cs-137
2018	EC-JRC-REM 2018 proficiency test on 222Rn massic activity measurements in water	Water	1	Rn-222
2018	IAEA-TEL-2018-04 ALMERA proficiency test on determination of anthropogenic and natural radionuclides in water, soil sample	Water	1	Cs-137, Cs-134, Ba-133, Am-241, Sr-90, Co-60
			1	Cs-137, Cs-134, Na-24, Sr-90, Am-241, Mn-54, Co-60, Ag-110m, Be-7, Br-82, Co-58, Cs-136, Fe-59, I-131, I-133, K-42, Mo-99, Xe-133
		Sediment		Ra-226, Ra-228, Am-241, Ba-133, Co-60, Cs-134, Cs-137, K-40
2018	Proficiency Test for Tritium, Strontium and Caesium Isotopes in Seawater 2018 (IAEA-RML-2018-01)	Seawater	1	Cs-137, Cs-134, Co-60, Ba-133, H-3
2019	Proficiency Test for Tritium, Strontium and Caesium Isotopes in Seawater 2019 (IAEA-RML-2019-01)	Seawater	1	Cs-137, Cs-134, H-3
2019	IAEA-TEL-2019-04 ALMERA proficiency test on determination of anthropogenic and natural radionuclides in water, shrimp and aerosol filter samples sample	Water	2	∑ α ja β, Cs-137, Cs-134, Ra-226, Ra-228, Sr-90
		Shrimp	1	K-40, Ra-228
		Aerosol filter	3	Cs-137, Cs-134