EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

Directorate D – Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

ESTONIAN NATIONAL MONITORING NETWORK FOR ENVIRONMENTAL RADIOACTIVITY

REPUBLIC OF ESTONIA

1 - 4 June 2010

Reference: EE-10/04

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FACILITIES	Monitoring network for environmental radioactivity in Estonia
SITES	Tallinn, Harku, Sillamäe, Narva-Jôesuu, Türi, Pärnu
DATE	1 – 4 June 2010
REFERENCE	EE-10/04
INSPECTORS	V. Tanner (team leader)
	P. Vallet
	A. Ryan
	C. Hanot
DATE OF REPORT	25 November 2010

SIGNATURES

V. Tanner	P. Vallet
A. Ryan	C. Hanot

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TECHNICAL REPORT

ABBREVIATIONS

DG ENER	Directorate-General for Energy
EC	European Commission
EIA	Environmental Impact Assessment
EB-RSD	Environmental Board - Radiation Safety Department
EMHI	Estonian Meteorological and Hydrological Institute
EURDEP	European Radiological Data Exchange Platform
FWHM	Full Width at Half Maximum
GM	Geiger-Müller
HELCOM	Helsinki Commission
HPGe	High Purity Germanium
IAEA	International Atomic Energy Agency
ISO	International Standardization Organization
PMS	Permanent Monitoring Station
PET	Positron Emission Tomography
UPS	Uninterruptible Power Supply

1. INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the Basic Safety Standards(1).

Article 35 also gives the European Commission the right of access to such facilities in order that it may review and verify their operation and efficiency.

For the EC, the Directorate-General for Energy (DG ENER; formerly Directorate-General for Energy and Transport - DG TREN) and in particular its Radiation Protection Unit (ENER.D.4) is responsible for undertaking these verifications.

The main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for (as far as applicable in the Member State):

- Liquid and airborne discharges of radioactivity into the environment by a site (and control thereof).
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways.
- Levels of environmental radioactivity on the territory of the Member State.

For the purpose of such a review, a verification team from DG ENER visited the Sillamäe remediation project area, the North Estonia Medical Centre (Tallinn), monitoring sites, as well as the laboratory which is part of the national monitoring system for environmental radioactivity. The visit included meetings with representatives of the Radiation Safety Department of the Environmental Board (EB-RSD), with representatives of the Ökosil company (Sillamäe remediation project area) and with representatives of the North Estonia Medical Centre. With due consideration to the scope of the verification mission and taking into account the relatively short time available for the execution of the programme, it was agreed that emphasis would be put on:

- Environmental radioactivity monitoring arrangements at the Sillamäe area
- Discharge monitoring at the North Estonia Medical Centre
- Analytical laboratory of the Radiation Safety Department of the Environmental Board
- National environmental monitoring and sampling programme

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance of radioactivity on the territory of Estonia. The report is also based on information collected from documents received and from discussions with various persons met during the visit.

This visit was a re-verification of the first Estonia verification, which took place in 2005. After the first verification the Estonian administrative system managing the monitoring programme has been completely reorganised and therefore the Commission considered a re-verification necessary.

The verification team acknowledges the excellent co-operation it received from all participating individuals.

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

2. PREPARATION AND CONDUCT OF THE VERIFICATION

2.1. Preamble

The Commission's decision to require the conduct of verifications under the terms of Article 35 of the Euratom Treaty was notified to the Estonian Government on 17 February 2010 (letter referenced TREN/H4/CG/rm D(2010)53791, addressed to the Permanent Representative of Estonia to the European Union). The Estonian Government designated the Radiation Safety Department of the Environmental Board (EB-RSD) to lead the technical preparations for this visit. Subsequently, practical arrangements for the implementation of the verification were made with the EB-RSD.

2.2. Preparatory documents

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Estonian authorities, in the form of answers to a questionnaire prepared by the Commission services. Additional documentation was provided during and after the verification visit. A list of this documentation is compiled in Appendix 1. The information provided has been extensively used for drawing up the descriptive sections of this report.

2.3. Programme of the visit

A programme of verification activities under the terms of Article 35 was discussed and agreed upon with the Estonian competent authority (EB-RSD).

The programme comprised verification of the monitoring arrangements at Sillamäe remediation project area, at stations belonging to the national monitoring system, at the EB-RSD laboratory and at the North Estonia Medical Centre.

A summary overview of this programme of verification activities is provided in Appendix 2. The verification activities were carried out in accordance with this programme. At the locations listed in the programme the verification activities addressed technical aspects of monitoring and sampling, analytical methods used, quality assurance and control, archiving and reporting of data.

On 1 June, an opening meeting was held at the EB-RSD centre. The closing meeting was held at the same place on 4 June.

2.4. Representatives of the Estonian competent authorities and the associated laboratories

Environmental Board – Radiation Safety Department, Tallinn, representing the Ministry of the Environment

Mr. Ilmar Puskar	Head of Radiation Safety Department
Mr. Toomas Kööp	Adviser
Ms. Eia Jakobson	Head of laboratory
Mr. Mihkel Visnapuu	Chief Specialist of Radiation Monitoring Bureau
Mr. Peeter Parder	IT specialist

Mr. Alar Polt	Chief Specialist of Radiation Monitoring Bureau

Ökosil company, Sillamäe

Mr. Anti Siinmaa	CEO
Mr. Vladimir Nosov	Technical director
Ms. Dina Shestakova	Head of environmental laboratory
Mr. Vladimir Nosov	Technical manager
Mr. Pavel Pervak	Inspector

North Estonia Medical Centre

Dr. Sergei Nazarenko	Clinical Director

Narva-Jõesuu meteorological station (Estonian Hydrometeorological Institute)

Mr. Thomas Prüül	Head of Hydrometeorological Station

The verification team acknowledges the co-operation it received from all individuals mentioned.

3. BACKGROUND INFORMATION

3.1. General

Near Estonia there are two operational nuclear power plants: Loviisa (Finland) and Sosnovy-Bor (Russia). The legacy of the Soviet Union is also considerable. The most important nuclear legacy sites are the former naval nuclear training centre site at Paldiski and the Sillamäe uranium mining tailings pond, in addition to the general contamination of the environment by the Chernobyl accident. So, even if there is no nuclear programme in Estonia, monitoring of radioactivity in the environment is well justified.

The surveillance of artificial radiation and artificial radionuclides is included in the monitoring of radioactivity in the environment and foodstuffs. Exposure to natural radiation is controlled by research activities in case of suspicion that natural radionuclides may cause unusually high exposure of 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 natural 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 defining monitoring networks the principle of "sparse monitoring network"[2] has been followed. The smallness of the country and the financial limitations explain this.

3.2. Responsible organisations

Pursuant to the Radiation Act that entered into force in 2004, the Ministry of the Environment organises the activities related to radiation protection of the Environmental Inspectorate and the Radiation Safety Department of the Environmental Board (EB-RSD). EB-RSD is the main responsible organization for the monitoring programme of radioactivity in environment and foodstuffs in Estonia. The responsibility of the overall monitoring is under the Ministry of the Environment. EB-RSD is in charge of the radiological monitoring under an annual contract and it receives an annual budget for this purpose.

The Veterinary and Food Board within the jurisdiction of the Ministry of Agriculture carries out monitoring of agricultural products and supervision activities associated with food safety.

Two radioanalytical laboratories are involved in environmental monitoring in Estonia. In EB-RSD there is the main laboratory for the national environmental radioactivity monitoring programme. Monitoring of the Sillamäe site is delegated to ÖkoSil Ltd Environmental Laboratory which does some of the measurements itself and outsources the others.

4. LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING IN ESTONIA

Estonia has basic legislation in the area of radiation and nuclear safety. The main legal acts regulating the environmental radiation monitoring are:

Legislative acts regulating environmental monitoring issues:

- Environmental Monitoring Act (RT I[3] 1999, 10, 154);

2. According to Commission recommendation 2000/473/EURATOM of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole

3 RT = Riigi Teataja = State Gazette

- Radiation Act (RT I 2004, 26, 173);
- Integrated pollution prevention and control act (RT I 2001, 85,512; RT I 2002, 61, 375; RT I 2003, 73, 486);
- 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 L 2005,65,934);
- Statutes of the Environmental Board (RT L, 23.01.2009, 9, 107).

Legislative acts regulating foodstuffs monitoring:

- Directive of the Council of European Communities 96/23/EC (OJ L 125, 23.05.1996);
- Rules of procedure for the regulation of monitoring of contaminants in foodstuffs of animal origin and methods for taking control samples and analyses thereof, (RT L 2003, 11 123).

In addition to the binding legal requirements, there are important guidance documents relevant to the environmental radiation monitoring. The most important ones are:

- Commission Recommendation of 8 June 2000 on the application of Article 35 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 (2000/473/Euratom);
- HELCOM Recommendation 26/3 – Monitoring of radioactive substances.

5. ENVIRONMENTAL RADIOACTIVITY MONITORING IN ESTONIA

5.1. External ambient gamma dose rate

An automatic network consisting of two independent sub-networks continuously measures the gamma dose rate. All radiological information is stored in the common PMS database. Radiological data are transferred daily to the dialling servers in the EB-RSD. The locations of both types of measurement stations are presented in chapter 6.1 (Figure 1) and the exact coordinates in Appendix 3.

The older sub-network is "the area radiation monitoring system" AAM-95, which includes three automatic local stations. Theses stations measure the total environmental gamma dose rate. They are connected to the server situated in EB-RSD. The pre-set alarm level is 0.3 μSv/h in all stations. In case a value above this pre-set alarm is detected, the stations send an alarm message to the central server.

The newer part of the countrywide network consists of seven PMS stations. These are fully automatic stations, which measure the total gamma dose rate as well as gamma spectra (NaI). The latter feature makes it possible to discriminate between an increase in the dose rate due to natural radioactivity and an increase due to contamination by artificial radionuclides. The stations analyse the dose rates from five different sets of isotopes for which independent alarm levels are preset, providing early warning even in the case of low levels of atmospheric contamination. Measurement integration time and interval lengths for data sampling are separately adjustable for each station from the EB-RSD.

The alarm values are as follows:

Total gamma dose rate	200 nSv/h
Dose rate from artificial sources	95 nSv/h

Alarm messages are stored in the main server and distributed through an Internet service to the mobile phones of the duty specialists.

5.2. Airborne particulates

Airborne radioactivity is monitored in larger Estonian towns to provide information for decision-makers about the concentration of radioactive particles in the atmosphere. Three air filtering stations are installed. They are situated in meteorological stations in the vicinity of the larger cities. The locations of these three stations are presented in Appendix 3 (Figure 1) and exact coordinates in Appendix 3 (Table 1).

The oldest filter station is located near Tallinn at the Harku site. It was designed and constructed in 1994 in a local small technological bureau. Its design is very basic, without a gauge for permanently measuring the air flow and calculating the filtered air volume. It was designed to sample air particles using Petryanof type filters. This type of filter material has insufficient adsorption ability for small aerosol particles. Because of this, the isotope data measured on filters from this site are used with caution.

In late 1996 a modern air filter station *Snow White JL 900* (Senya Ltd., Finland) was installed in Narva-Jõesuu for detecting, as soon as possible, air contamination in the event of a nuclear accident at the Leningrad Nuclear Power Plant at Sosnovy Bor. A large volume HPGe detector is used in the laboratory to analyse the gamma spectra of the glass fibre and activated charcoal filters from this station.

In 1997 a smaller air filter station *Hunter Jl 150* was installed in Tõravere, in the south-eastern part of Estonia.

In all stations the filters for air particles are changed once a week. In the analytical laboratory of EB-RSD in Tallinn, radioanalytical measurements of filters by a gamma-spectrometer are performed. In spectrum analyses the presence of practically all possible artificial and natural radionuclides is checked. Routinely Cs-137 and natural Be-7 are detected in the samples.

In case of an unusual radiological situation, indicated by the concentration of artificial isotopes above 10 $\mu Bq/m^3$ in the air, the filter change frequency will be increased.

5.3. Surface water

Radioactivity of surface water is monitored in inland waters. Two sampling stations have been defined at the largest rivers of the country: at river Narva and Pärnu. The locations of theses two sampling stations are presented in Appendix 3.

The radioactivity of water in river Narva is affected by radioactive contaminants of Chernobyl origin deposited on the large catchment area in eastern Estonia. This area covers lake Peipus and the drainage areas of rivers feeding the lake, both on Estonian as well as on Russian territory. The catchment area of the river Pärnu is located in southern Estonia.

5.4. Marine monitoring

Radioactivity in the marine environment is monitored in the area of the Gulf of Finland by taking samples in the stations defined by the HELCOM Recommendation 26/3. Sample types and radioisotopes measured also correspond to this guidance. There are different sampling stations for sea water and other marine samples. Locations of these sampling stations are presented in Appendix 3.

5.5. Drinking water

For drinking water monitoring purposes two sampling stations have been defined. One is dedicated to water taken from a surface water reservoir (lake). Water coming from this station is analysed for artificial radionuclides. Another one is dedicated to water from a deep underground aquifer. Water coming from this station is analysed for natural radionuclides. The locations of theses sampling stations are presented in Appendix 3.

5.6. Milk produced in Estonia

The milk products sampling in Estonia is done by the Veterinary and Food Board based on a co-operation agreement. Samples are collected from the biggest milk dairies in three counties (Harjumaal, Järvamaal and Tartumaal). At the end of every quarter, monthly samples are combined and analysed for artificial radionuclides and K-40. The locations of these sampling stations are presented in Appendix 3.

5.7. Foodstuffs and mixed diet

The verification team received a copy of the 2010 annual sampling programme for foodstuff and feeding stuff. This list (see Appendix 3) establishes a list of various products with their sampling frequency and locations. This annual programme started after the first verification in 2005 following one of the recommendations issued by the team.

The Veterinary and Food Board is responsible for foodstuffs monitoring under the responsibility of the Ministry of Agriculture. The EB-RSD laboratory handles the radiological measurements, following their national annual monitoring programme.

Monitoring of radioactivity in mixed diet is carried out at two sites: food depot of the North Estonia Medical Centre (Tallinn) and Tartu University Hospital. It is dealt with as an additional indicator of public dose. The sampling sites represent large population groups and the average daily food for adult persons. Samples including drinks are taken twice a year and analysed for K-40, Cs-137 and Sr-90.

5.8. Products from natural ecosystems

Since areas in north Estonia were contaminated by Chernobyl fallout there is a monitoring programme for radioactivity in such natural products which can be consumed by a large number of people (wild berries, game and mushrooms). There might be some export of these products, but not on commercial levels. During the past years, there has been up to 9 samples of wild berries and up to 14 samples of mushrooms a year (2007 and 2008). In 2009 and 2010, only one or two samples of each were collected due to the restructuring of EB-RSD and shortage of staff. However, it is planned to increase the number of samples for berries and mushrooms. Samples are analysed for Cs-137 and K-40.

5.9. Food of animal origin

Foodstuffs of animal origin are monitored by the Veterinary and Food Board according to the programme based on Directive 96/23/EC. The presence of contaminants in foodstuffs of animal origin is monitored based on the annual control programme; in addition random samples are collected and analysed.

5.10. Sillamäe site monitoring

Sillamäe site is an old industrial complex where, among other things, uranium mining and milling was carried out during the Soviet-era. There is also a plant for rare and rare-earth metals production. Uranium operations have been stopped, but production of other metals continues.

Radioactive and toxic tailings from the uranium production era were collected in a large tailings pond next to the facility very close to the Baltic Sea. A large-scale internationally funded remediation project was completed in October 2008 by the environmental company Ökosil. Now the tailings pond area is being re-vegetated and subject to routine environmental monitoring according to a 2008 ministerial decision.

5.11. Paldiski site monitoring

Paldiski was the site of a Soviet (subsequently Russian) naval base from 1968 to August 1994. The former base covers an area of 650 hectares. In 1995 the Russian authorities signed a document that handed over control of the area to Estonia. At the signing of the document finalizing the transfer of Paldiski to Estonia, it was announced that both pressurized water submarine training reactors on site had been dismantled and the nuclear fuel had been removed and transported to Russia. It was also announced that the concrete sarcophagus for the decommissioned reactors was complete.

The Paldiski site is currently being managed by company AS ALARA Ltd (Estonian Radioactive Waste Management Agency). It is a state-owned company set up by the Estonian government. AS ALARA Ltd. deals with the sanitation of the Paldiski nuclear facility and the environmental monitoring programme.

The Commission verification team visited the site for the first time in 2005. A re-verification was not foreseen.

5.12. Medical facilities

There are a few medical facilities in Estonia, which use radioactive materials for medical purposes and also discharge them in the environment in either liquid or gaseous form. Medical nuclides are short lived and the amounts of discharged radioactivity at present are considered so small that there are no regulatory requirements for discharge monitoring or environmental monitoring around the facilities. There is no dose reduction equipment (delay tanks) at the medical facilities either.

6. VERIFICATION ACTIVITIES

6.1. National monitoring programme

The verification team verified the structure of the national programme. Monitoring is carried out in the locations presented in Figure 1. The programme consists of the following:

- Automatic ambient gamma dose rate measurement network (3 stations)
- Automatic PMS-station network (5 stations)
- High volume air samplers (3 stations)
- Surface water sampling (rivers)
- Drinking water sampling
- Milk sampling
- Foodstuffs sampling (mixed diet and individual foodstuffs)
- Marine sampling (seawater and sediments)

High level readings on the automatic system generate an alarm to the EB-RSD radiological emergency duty staff. Dose rate data is made available automatically to the EURDEP system.

Figure 1. Radioactivity monitoring locations in Estonia

Although the structure of the programme and the involved facilities are quite the same as they were during the 2005 verification, some changes have been made:

- Mixed diet samples are now taken twice a year from 2 places (only 1 sample formerly).
- More individual foodstuffs are sampled (food grain, meat, vegetables – altogether 6-10 samples per year).

- Cooperation with the Estonian Marine Institute (University of Tartu) has been initiated for taking marine samples by accredited sampling personnel.
- Grass samples are taken every year near the Paldiski site as a mandatory part of the Paldiski monitoring program.
- EB-RSD has established contacts with the Estonian Meteorological Office to receive rain water samples if needed, but these are not part of the regular programme.

Results of the programme are made available as an annual report to the Ministry for Environment. In addition selected results are available at the EB-RSD website and transmitted to the EC in accordance with Article 36 of the Euratom Treaty.

Verification does not give rise to particular recommendations. The verification team notes that modernisation of the system equipment will soon become necessary.

6.2. EB RSD laboratory

General

The laboratory carries out all the analysis of environmental samples collected in Estonia as part of the national monitoring programme. Food samples are analysed under order from the Veterinary and Food Board (VFB) to whom the results are sent after analysis. In addition the laboratory undertakes contract analysis for other organisations and private companies (building materials, foodstuffs, etc…).

The laboratory is accredited under ISO 17025:2005 for gamma spectrometry. The accreditation certificate, issued on 29/4/2010 is valid until 28/4/2015. In 2005 it was envisaged to achieve accreditation for other methods. However, this has not been achieved, mainly for budgetary reasons.

Extensive participation in intercomparison exercises is encouraged and results are consistently in line with other participants. This is seen as a useful method of testing the laboratory's performance in a cost effective way.

Three specialists are employed in the laboratory and each is able to perform most of the analyses carried out. In general calibrations are carried out by the Head of the Laboratory. Cooperation within the team is excellent and backup is assured.

Verification does not give rise to particular recommendations. The verification team supports the on-going work towards accreditation of other laboratory analysis methods and acknowledges the extent of the intercomparison exercise activity.

Sample receipt and pre-treatment

Incoming samples are received in a sample pre-treatment room, which houses a sample storage cabinet, a refrigerator and a hydraulic sample press. Filter samples from Harku, Tõravere and Narva-Jõesuu arrive by mail along with their relevant collection information sheet. A contamination check is performed on each sample.

All samples, regardless of where they come from, are noted in chronological order in the laboratory's log book. There is a clear distinction between samples which are part of the statutory programme and those carried out under contract. Containers are identified with the reference number attributed, the weight and date of the sample taking. A sample sheet accompanies each sample throughout the process. In addition to the log book samples are noted in an electronic database. There are no numbers on incoming filter samples; a number is allocated after pressing. There is usually only one sample received at a time, so there should be no risk of confusing samples. A similar receipt procedure is in place for incoming water samples (50/30 litres). Water samples are evaporated according to the laboratory Quality Manual.

Potentially high activity samples, e.g. Paldiski environmental samples, are kept apart from other samples to avoid any risk of cross contamination.

Dedicated dishes are used for milk samples from different locations to ensure that nothing interferes with the quality of the analysis.

All samples are kept for three months, which is the limit defined in the laboratory Quality Manual. Thereafter filter samples are sent to the University of Tartu for research purposes. All documents and manuals are stored in the analysis office; all lab personnel know where the manuals are.

Verification does not give rise to particular remarks.

Ashing and drying

The procedures for ashing and drying are detailed and comprehensive. There are three furnaces for ashing samples (450ºC maximum) and two drying ovens. One furnace is reserved for potentially contaminated material. The furnaces are certified and maintained by the supplier and checked every two years. Samples which are dried/ashed are mainly analysed for Sr-90.

Verification does not give rise to particular remarks.

Scales

The laboratory uses electronic scales, which are calibrated annually by an external calibration service. Calibration files and monthly control files were available.

Verification does not give rise to particular remarks.

Gamma spectrometry

The laboratory operates three gamma-spectrometry systems; one analogue Oxford, one digital Canberra (low energy system with carbon composite window) and one analogue BSI (Baltic Scientific Instruments) system. A UPS system is available, but there is no long-term electrical back-up. Records for liquid nitrogen supply and instrument control (Energy and peak width (FWHM) for Co-60 and Cs-137) were available. The calibration procedure includes self-attenuation and summing corrections.

ISO 17025 accreditation is in place for gamma spectrometry measurements, covering 1 litre and ½ litre Marinelli beakers, half and whole Williams and 60ml containers. Only the two most recent systems, Oxford and Canberra, are accredited.

For routine analyses the Oxford and Canberra systems are used with the BSI system serving as a backup in case of either is out of order. At the time of the visit the BSI system was itself out of order and it is under discussion whether to send it to Latvia for repair or to replace it altogether.

The gamma spectroscopy room has air conditioning. Temperature and humidity are continuously monitored. The room is fairly small, leaving little space for new equipment. Samples are measured for a maximum of 24 hours. Long measurement times limit the system throughput, so in the event of an emergency the laboratory quickly becomes overloaded.

All three gamma-spectroscopy systems use different electronics and software. This is a problem, since staff has to learn to use each system and having different systems increases the probability of error and limits measurement flexibility.

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.

Liquid scintillation counting

The laboratory has a Wallac 1415 liquid scintillation counter, operating in DOS mode, which is over 10 years old but still fully functional. Since the visit in 2005 a modern Perkin Elmer Quantulus 1220 using the Easy View programme has been put into operation. ^{3}H-analyses are carried out both as a part of the national programme and on contractual basis for AS ALARA Ltd Paldiski monitoring programme.

Verification does not give rise to particular remarks.

Alpha spectroscopy

The laboratory has four Tennelec 256 Alpha Spectrometers, but these have been out of order for several years. As there is no routine analysis foreseen it is currently not envisaged to repair this equipment. Furthermore long chemical preparation is necessary and staff would need to be specially trained for this specialised task.

Verification does not give rise to particular recommendations. Verification team notes that if resources are made available, maintaining capability to carry out alpha spectroscopy should be included in the long term development of the laboratory.

Standards

Gamma ray emitting standards are kept in a locked and alarmed storage room at a sufficient distance from the HPGe-detectors to avoid interference. Czech Republic origin multinuclide standards are used for gamma spectroscopy system calibration. Activity certificates issued by the Mendelejev Institute in Russia and the Czech Metrological Institute were available.

Verification does not give rise to particular remarks.

Results archive

Laboratory analysis results are archived for ten years on paper and on computer; monitoring results are kept permanently. The files are kept on the laboratory PC and on a central server. The results are not signed by staff, but the analyst is identified in the files. The database can be accessed by all co-workers but only the laboratory staff can make changes to records.

On request the laboratory staff was quickly able to retrieve results for samples selected at random from the sample log book.

Verification does not give rise to particular remarks.

6.3. Automatic measurement network

The Estonian automatic measurement network remains almost as it was during the 2005 verification. The verification team verified the functionality of the system data centre at the premises of the EB-RSD. Data is collected from the network stations daily, in the event of an emergency hourly. Data is available locally and also supplied automatically to the EURDEP system. The system consists of a PMS-server, database server and a UPS. In addition there are three modems for communication with the network dose rate stations (Alnor) and the PMS stations. Data back-up is made weekly on a CD, CD's are kept in a safe.

The system does not have a user-friendly graphical (map) local data display, so the most convenient way to view the data is by using the EURDEP system map. The plan is to renew the system in 2011 when a new data centre will be built at the new EB-RSD office.

Verification does not give rise to particular recommendations. The verification team supports the planned modernisation of the system data centre, especially the creation of a user friendly graphical data display.

6.4. Mobile measurement vehicle

The EB-RSD has one Nissan Patrol 4x4 vehicle equipped with a 4-litre Exploranium Nal detector and an EnviSPEC GR-320 measurement unit working with GPS navigation system and linked to a PC. However the Exploranium detector is out of order and it must now be decided if a new vehicle should be purchased or if the detector should be replaced, depending on financial resources. In the meantime, a backpack detector, manufactured by Atomex in Belarus is used.

The vehicle is kept on stand-by only for emergency situations, as there are no plans for routine mobile environmental monitoring. One team leader and 5 duty officers are trained to use the equipment but only two persons could use the car, if necessary. Five Fieldspec RO20 ion chambers and one Exploranium mini spec are in storage and can be deployed in the field if needed.

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.

6.5. PMS system in Tallinn

The verification team visited the PMS system located in the EB-RSD premises. It is the only PMS station not maintained by the Estonian meteorological service. As all PMS stations, it comprises a NaI detector, GM-tube, rain detector (not heated), temperature sensor and a humidity sensor. The equipment is located in a locked cabinet on the roof of the EB-RSD entrance building. This station is polled by the system server on 10 minute intervals. It has a battery back-up. The verification team noted that there is no ladder long enough to enable access to the roof in order to clean the inside of the rain bucket in case of obstruction.

Verification does not give rise to particular remarks.

6.6. Harku meteorological station

The verification team visited the Harku meteorological station. The Harku meteorological station is manned on a 24h basis. There is a high-volume air sampler constructed locally in 1994 and working since 1995. Flow calibration had been performed in the past (September 1995) and was found to be about 700 l/s. There is no flow measurement but there is a request for having a flow-meter. The filters coming from this station are analysed by EB-RSD. The verification team was informed that there have been no temperature related problems during winter time.

Verification does not give rise to particular recommendations. The verification team supports the efforts to equip the station with an airflow meter.

6.7. Pärnu meteorological station

The verification team visited a standard PMS station with gamma dose rate measurement online at Pärnu Airport, one of seven PMS stations comprising the countrywide network. It is a new generation fully automatic station which measures the total gamma dose rate as well as gamma spectra (NaI). The latter feature makes it possible to discriminate between an increase in the dose rate caused by natural activity and contamination by artificial radionuclides. The stations analyse the dose rates from five different sets of isotopes for which independent alarm levels are preset, providing early warning even in the case of very low levels of atmospheric contamination. In addition, the stations record the amount of rain and the local temperature.

Verification does not give rise to particular recommendations. The verification team notes that the monitoring equipment is getting old and therefore should be renewed in a near future.

6.8. Türi meteorological station

The verification team visited a gamma dose rate monitoring station with dose rate measurement online at Türi, located at the weather station of EMHI (Estonian Meteorological and Hydrological Institute). The gamma detector is located outdoors within the area of the meteorological centre and the ALNOR electronic equipment is kept locked inside. Data are sent once a day to the EB-RSD through telephone lines. In case of an alarm, data can be sent every 10 minutes.

Verification does not give rise to particular remarks.

6.9. Narva-Jõesuu Meteorological station

The verification team visited the Narva-Jõesuu meteorological station located at the border between Russia and Estonia, some 65 km from the Russian Sosnovy-Bor nuclear power plant (RBMK type).

The station has a Snow White JL-900 high-volume air sampling system installed on the building roof. The system is operated in six hour cycles in order to save electricity. The station measures independently the filtered air volume and operation time. The system has been operational for over ten years. Filter (Whatman GF/A glass fibre 46x57 cm) change is performed each Monday by the local staff. The filter is sent by mail to the EB-RSD laboratory in Tallinn along with a sampling information sheet.

There is also a standard PMS monitoring station at Narva-Jõesuu, which is identical to the system in Tallinn. During the verification the PMS station electronics unit was in process of being moved downstairs to a new location, the monitoring equipment stays on the roof.

Verification does not give rise to particular recommendations. The verification team notes that the monitoring equipment is getting old and therefore a renewal or a refurbishment project will become necessary in a near future.

6.10. North Estonia Medical Centre

The verification team visited the North Estonia Medical Centre, which is for patients with highly specialised diagnostic needs. As an aid to understanding the processes which may give rise to radioactive discharges the verification team was given a very comprehensive presentation of the development of nuclear medicine in general and PET in particular. There are two other hospitals with nuclear medicine in Estonia (one in Tartu and one in Tallinn).

In the North Estonia Medical Centre, there is a PET system. It's a nuclear medicine imaging technique which produces a three-dimensional image or picture of functional processes in the body. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radionuclide (tracer), which is introduced into the body on a biologically active molecule. Images of tracer concentration in 3-dimensional or 4-dimensional space (the 4th dimension being time) within the body are then reconstructed by computer analysis.

The biologically active molecule chosen for PET is FDG (fluordeoxyglucose), an analogue of glucose. The concentrations of tracer imaged then give tissue metabolic activity, in terms of regional glucose uptake. The FDG used is produced by MAP Medical Technologies (Finland). It arrives by aeroplane (the airport is only 10 minute away). One or two days before the delivery, the quantity needed is calculated based on the number of patients to be treated. The hospital records all the radioactive substances bought (every 3, 6, and 12 months).

The patients arrive one hour before the injection and receive instructions. After injection, they wait 40 to 60 minutes (for accumulation) and then they are scanned.

After the scan, patients stay again in the hospital for 2 or 3 hours. They are then monitored clinically (also for potential allergy). During this time, they must drink at least two times and use separated toilets. There is no delay tank for radioactive liquid waste because there should be no significant radioactivity in the urine. The hospital follows IAEA's recommendations on discharge monitoring.

Syringes used are collected and stored for 1 or 2 days. The absence of significant radioactivity is then checked with a dose rate meter and then the syringes are classified as regular medical waste. Vials of FDG are stored in the shielded delivery container. After a certain time (at least 10 times the half-live of 109.8 min) the absence of significant radioactivity above a normal background is checked. Then the vials are also considered as regular medical waste and returned to MAP.

For other diagnostics, the hospital doesn't use iodine anymore but only technetium. The ampoules and syringes follow the same treatment as for the "wastes" of FDG. After at least 10 times the half-live, the absence of significant radioactivity above the normal background is checked, thereafter they are also considered as regular medical waste.

In the past, there has also been therapy with iodine. There was no delay tank because the dilution was estimated sufficient for the discharged activity, in accordance with the IAEA's recommendations. The hospital has planned to restart therapy with I-131. This project is currently in preparation and the hospital is waiting for some international recommendations coming from the IAEA.

The hospital also plans to install a cyclotron for production of medical radioisotopes. It's a part of what it is called "Project 2011-2014".

The verification team was informed that currently there are no radioactive gaseous discharges from the hospital.

Verification does not give rise to particular recommendations. The verification team points out that should the amounts of radioactivity used in the North Estonia Medical Centre increase there will be a need to assess the possible doses to the general public due to the discharges and consider establishing a discharge monitoring programme or installation of dose reduction measures (delay tank).

6.11. Sillamäe site

The Commission verification team visited the Sillamäe site for the first time in 2005 during the tailings pond remediation work, so this was a re-verification of past recommendations and an update of the environment monitoring status on site.

The verification team was introduced to the current status of the project. The Ökosil Company has maintained the site environment monitoring programme on the same magnitude as it was during the 2005 verification. In 2009 a formal decision was made on the future monitoring of the site. Financing the monitoring programme is secured for 2010-2011, but there is still no long-term financing decision. Cost of the monitoring programme is estimated at 150 000 € per year.

The verification team was informed that the level of public interest towards the remediation project has decreased after the 2005 verification; generally speaking the site is not subject to significant public concern anymore.

The current annual monitoring programme was implemented by the Ministry of the Environment order number 1859/21.10.2009 "*Sillamäe radioaktiivsete jäätmete hoidla järelseire"*. The programme consists of the following:

- Sampling of 12 ground water wells 4 times per year (concentration of U-238, Th-232 and Ra-226)
- Gamma dose rate measurements at 10 points 4 times per year
- Radon exhalation measurements at 5 points 4 times per year

The Ökosil laboratory has a quality manual according to the ISO 17025 standard and it has participated in intercomparison exercises with the Wismut site laboratory in Germany. Twice a year the laboratory produces reports on the Sillamäe monitoring programme.

Laboratory monitoring equipment is all portable; there are no fixed monitoring installations on site. The equipment consists of dose rate monitors (several types), a total alpha counter (Eberline FHT 7705 one chamber counter), a radon monitor (Alpha Guard) and an aerosol sampler for field measurements.

The results of the monitoring programme are owned by the Ministry for Environment and therefore it decides on their publication. In general this type of information has not been made public. The monitoring report of the 2009-10 programme was presented to the team.

> *Verification does not give rise to particular recommendations. 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.*

7. REVIEW OF THE 2005 RECOMMENDATIONS

In 2005 the Commission verification team made the following recommendations:

National monitoring programme

> *The verification team suggests comparing the Estonian national monitoring programme with other Member States, looking essentially at the nature and frequency of sampling. The verification team recommends a revision of the programme in order to correct the deficiencies identified and to bring the programme in line with good practises adopted in other Member States.*

This recommendation has been followed fairly well: the 2010 programme is more extensive than in 2005 although the available resources are still very limited. Despite the lack of funding and government services reorganisation the Estonian authorities have been able to adequately maintain the level of monitoring. However, in order to maintain and improve it in the future there will soon be a need to modernise the equipment and involve additional personnel in the programme.

Monitoring laboratory

In order to improve measurement service reliability and reduce complexity the verification team recommends that the gamma-spectroscopy hardware and software in the ERPC analysis laboratory be developed towards a more harmonised system, which would allow for greater flexibility in the measurement operations and have sufficient measurement capacity also for emergency situations. This would also improve comparability of results and make training and maintenance easier.

Whilst the recommendations have not been followed, due in part to lack of funding, no deterioration in quality was noted. However, as staff is limited this could become an issue should any decrease in staffing intervene.

Automatic measurement network

The verification team recommends the ERPC to ensure permanent availability of competence in the handling and maintenance of the on-line monitoring system central database.

This recommendation has been followed, although it appears that the required competence remains with only one staff member. The upcoming removal of the IT-systems to the new laboratory will require strong expertise in this area.

Mobile measurement vehicle

The verification team suggests making sure there is enough trained staff to operate the vehicle on a continuous basis during emergency situations.

This recommendation has not been fully followed, since apparently the number of trained staff to operate the vehicle remains low. During the verification the detector mounted on the vehicle was out of order, so apart from handheld equipment there was no possibility to make mobile measurements.

Sillamäe site

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.

This observation remains valid, since although the monitoring has been successfully carried out in 2005 - 2010 there is still no decision on long-term financing for the programme.

8. CONCLUSIONS

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

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

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

(2) However, a few improvement suggestions are formulated. These suggestions aim at improving some aspects of the environmental surveillance. These suggestions do not detract from the general conclusion that the Estonian national monitoring system is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(3) The recommendations presented in this report are summarized in the 'Main Findings' document that is addressed to the Estonian competent authority through the Permanent Representative of Estonia to the European Union.

APPENDIX 1

REFERENCES AND DOCUMENTATION

1) National monitoring programme of radioactivity in environment and foodstuffs in Estonia, preparatory information for the verification provided by EB-RSD

2) Questionnaire on the implementation of Art. 35 of the EURATOM Treaty in the Republic of Estonia, EB-RSD, 2010

3) Environmental monitoring and control program for Sillamäe radioactive tailings pond remediation, Report no. E745, Ökosil Ltd.

4) Country Waste Profile Report for Estonia (IAEA), 2000

APPENDIX 2

VERIFICATION PROGRAMME

Tuesday 01/06

1. **AM** Opening meeting: introduction, presentations and details of the programme
2. **PM** Team 1 starts verification activities at the North Estonia Medical Centre (Tallinn).
3. **PM** Team 2 starts verification activities (foodstuff and feeding stuff sampling arrangements; Tallinn and surrounding region + laboratories).

Wednesday 02/06

4. Team 1 travels to the Sillamäe remediation project area (verifies monitoring arrangements) and to Narva-Jôesuu (verifies the PMS station and air sampler); return to Tallinn.
5. Team 2 travels to Pärnu (verifies monitoring facilities of the PMS station) + travel to Turi (verifies monitoring facilities); return to Tallinn.

Thursday 03/06

6. Team 1 continues verification activities (ambient gamma dose-rate on-line measuring system; environmental media sampling; Tallinn, Harku and surrounding region).
7. Team 2 verifies laboratories at Tallinn and surrounding region.

Friday 04/06

8. **AM** Closing meeting
9. **PM** EC verification team returns to Luxembourg

Team 1: Vesa Tanner and Patrick Vallet

Team 2: Alan Ryan and Cécile Hanot

APPENDIX 3

NATIONAL MONITORING PROGRAMME

Air monitoring stations in Estonia

No	Station	Gamma dose rate	Airborne particles (filtering)	Coordinates	
				N	E
1.	Harku		**F**	59°23'50"	24°35'58"
2.	Kunda	**A**		59°31'05"	26°32'44"
3.	Kärdla	**A**		58°59'38"	22°49'19"
4.	Mustvee	**A**		58°51'55"	26°57'09"
5.	Narva-Jõesuu	**A**	**F**	59°27'46"	28°02'45"
6.	Pärnu	**A**		58°22'53"	24°30'00"
7.	Sõrve	**A**		57°54'45"	22°03'25"
8.	Tallinn	**A**		59°26'55"	22°43'00"
9.	Tõravere		**F**	58°15'53"	26°27'42"
10.	Türi	**A**		58°48'34"	25°24'35"
11.	Valga	**A**		57°47'18"	26°02'00"
12.	Võru	**A**		57°50'43"	27°01'10"

A Gamma dose rate measurement on-line
F Sampling of airborne particles and aerosols by filtering

River Water

Sample type	Sample taking	Number of samples	Sampling point
Pärnu river (Catchment area 6900 km^2)	March May August October	4	Sindi bridge 58 25 02 ; 24 40 16
Narva river (Catchment area 56 200 km^2)	March May August October	4	Small resort place 59 25 50 ; 28 07 41

Drinking water

Sample type	Sample taking	Number of samples	Sampling point
Tallinna public supply	spring, autumn	2	North Estonia Medical Centre J. Sütiste tee 19, Tallinn
Maardu public supply	spring, autumn	2	Maardu Hospital Haigla 2, Maardu

Milk produced in Estonia

Sample	Sample taking	Number of samples	Sampling point
Harjumaal county	Defined by Veterinary service	4	Defined by Veterinary service
Järvamaal county	Defined by Veterinary service	4	Defined by Veterinary service
Tartumaal county	Defined by Veterinary service	4	Defined by Veterinary service

Mixed diet

Sample type	Sample taking	Number of samples	Sampling point
Daily ratio, solid and liquid for 1 patient	spring, autumn	2	North Estonia Medical Centre J. Sütise tee 19, Tallinn
Daily ratio, solid and liquid for 1 patient	spring, autumn	2	Tartu University Hospital L. Puusepa 8, Tartu

Sampling stations for sea water and other marine samples

Media	Station name	Coordinates		Remarks
		N	E	
Sea water	N8	59°28'30"	28°00'30"	Surface water
	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"	"
Bottom sediments	EE17	59°43'00"	25°01'00"	Differentiated by 2 cm interval, depth 20 cm
Fish	Sillamäe	59°28'00"	27°45'00"	Baltic herring and sprat
	Paldiski	59°22'00"	24°10'00"	"
Marine biota	Sillamäe	59°28'00"	27°45'00"	Aquatic plants, algae
	Paldiski	59°22'00"	24°10'00"	"

Foodstuffs produced in Estonia

Foodstuff	Sample taking	Number of samples	Sampling point
Potatoes	autumn	3	shop/market
Pork		1	shop/market
Beef		1	shop/market
Lamb		1	shop/market
Chicken		1	shop/market
Game	hunting season	1-2	shop/market
Grain		3	shop/market

Wild foods

Sample type	Sample taking	Number of samples	Sampling point
Forest mushrooms	autumn	1-2	N.E Estonia region
Berries	autumn	1-2	N.E Estonia region

Specific monitoring programmes

AS ALARA ltd

Sample type	Sample taking	Number of samples	Sampling point
Well water	Around solstice/equinox	4 x 4	Paldiski Tammiku
Mushrooms	autumn	1-2	Paldiski Tammiku
Berries	autumn	1-2	Paldiski Tammiku

AS Silmet

Sample type	Sample taking	Number of samples	Sampling point
Mushrooms	August-September	1-2	Sillamäe
Berries	August-September	1-2	Sillamäe

REQUIREMENTS FOR SAMPLE TAKING, ANALYSIS AND REPORTING

Sample type	Annual total samples*	Amount of each sample**	Accuracy and precision***
Airborne particles	3 stations x 52 weeks = 156 samples	Whole filter pressed into Williams container	Depends on nuclides measured Bq/sample (filter); measuring time 24 h.
River water	2 stations x 4 samples = 8 samples	30 litre	^{137}Cs – 0,005 Bq/l;
Drinking water	2 stations x 2 samples = 4 samples	50 or 10 litre	^{3}H – 10 Bq/l; ^{137}Cs – 0,005 Bq/l; ^{90}Sr – 0,005 Bq/l; ^{226}Ra – 0,05 Bq/l; ^{228}Ra – 0,1 Bq/l.
Milk	3 stations x 4 quarters = 12 samples	1,0-1,5 litre	^{137}Cs – 0,14 Bq/l; ^{90}Sr – 0,05 Bq/l; ^{40}K – 3,1 Bq/l
Mixed diet	2 stations x 2 samples = 4 samples	1 day ratio	^{137}Cs – 0,1 Bq/sample; ^{90}Sr – 0,05 Bq/ sample; ^{40}K – 5 Bq/ sample
Potato	3 samples	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 5,3 Bq/kg
Pork	1 sample	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 3,1 Bq/kg
Beef	1 sample	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 3, 1 Bq/kg
Lamb	1 sample	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 3,1 Bq/kg
Chicken	1 sample	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 3,1 Bq/kg
Grain	3 samples	1,5 kg	^{137}Cs – 0,14 Bq/kg; ^{40}K – 5,3 Bq/kg
Sea water	5 stations x 1 sample = 5 samples	50 litre	^{137}Cs – 0,005 Bq/l;
Sea plants	2 stations x 1 sample = 2 samples	~1,5 kg wet weight	^{137}Cs – 2 Bq/kg dry weight;
Mushrooms	6 samples	1,5 kg	^{137}Cs – 1 Bq/kg wet weight ^{40}K – 5,3 Bq/kg
Berries	6 samples	1,5 kg	^{137}Cs – 1 Bq/kg wet weight ^{40}K – 5,3 Bq/kg
Game	2 samples	1,5 kg	^{137}Cs – 1 Bq/kg wet weight ^{40}K – 3,1 Bq/kg
A.L.A.R.A wells	4 stations x 4 samples = 16 samples	1,5 litre	^{3}H – 10 Bq/l

* maximum number of samples
** minimum amount defined by laboratory carrying out the measurements
*** 95% of samples should be within the standard deviation