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DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

Directorate H – Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FINNISH NATIONAL MONITORING NETWORK FOR ENVIRONMENTAL RADIOACTIVITY

REPUBLIC OF FINLAND

19 to 23 March 2007

Reference: FI-07/02

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FACILITIES	Facilities for monitoring environmental radioactivity in Finland
DATE	19 to 23 March 2007
REFERENCE	FI-07/02
INSPECTORS	C. Gitzinger (team leader)
	V. Tanner
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	E. Henrich
DATE OF REPORT	22 October 2007

SIGNATURES

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ABBREVIATIONS

(N)EMP	(Nuclear) Electro-Magnetic Pulse
24/7	24 hours, 7 days per week
AAM	AreA Monitoring (Old Rados software)
BEGe Detector	Broad Energy Germanium Detector
BSS	Basic Safety Standards
DG TREN	Directorate-General for Energy and Transport
EC	European Commission
EIA	Environmental Impact Assessment
EURDEP	EUropean Radiological Data Exchange Platform
FINAS	Finnish Accreditation Service
FMI	Finnish Meteorological Institute
FWHM	Full Width at Half Maximum
GM	Geiger-Müller (radiation detector)
GPRS	General Packet Radio Service
GPS	Global Positioning System
HELCOM	Helsinki Commission
HELCOM COMBINE	Helsinki Commission – COoperative Monitoring in the Baltic marINe Environment
HELCOM MORS	Helsinki Commission – Monitoring Of Radioactive Substances
HPGe	High Purity Germanium (gamma radiation detector)
IAEA	International Atomic Energy Agency
ISO	International Standardization Organization
LIMS	Laboratory Information Management System
LINSSI	Database for Gamma-Ray Spectrometry
MCA	Multichannel Analyser
NaI(Tl)	Sodium iodine, thallium activated (gamma radiation detector)
PTB	Physichalisch-Technishe Bundesanvalt
PvTT	Puolustusvoimien Teknillinen Tutkimuslaitos (Finnish Defence Forces' Technical Research Centre)
QA	Quality Assurance
RODOS	Real time On-line Decision suppOrt System
SILAM	Regional scale dispersion modelling of fine particulate matter
SQL	Structured Query Language

STUK	SäteilyTUrvaKeskus (Finnish Radiation and Nuclear Safety Authority)
TETRA	TErrestrial Trunked RAdio
TKO	Tutkimus ja ympäristövalvonta (Research and Environmental Surveillance)
TLD	Thermoluminescence Dosimetry
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
USVA	Software for controlling and presenting external dose rate monitoring results
UTC	Universal Time Coordinated
VIRVE	TETRA based radio network for Finnish authorities
Y2K	Year two thousand
YVL	Ydinvoimalaitosten ympäristön säteilyvalvonta (Radiation monitoring around nuclear power plants)

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 (BSS)[1].

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

For the EC, the Directorate-General for Energy and Transport (DG TREN) and more in particular its Radiation Protection Unit (TREN H4) is responsible for undertaking these verifications.

For the purpose of such a review, a verification team from DG TREN visited sites located in Finland, which are part of the national monitoring system for environmental radioactivity. The visit included meetings with representatives of the Radiation and Nuclear Safety Authority (STUK), Finnish Meteorological Institute (FMI) and several municipal civil protection authorities.

The present report contains the results of the verification team's review of relevant aspects of the environmental radiation surveillance in Finland. The purpose of the review was to provide independent verification of the adequacy of monitoring facilities for air, soil, water and foodstuffs.

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:

- The structure of the national environmental monitoring and sampling programme;
- Analytical laboratories of the Finnish Radiation and Nuclear Safety Authority (STUK);
- On-line automatic monitoring systems;
- Environmental monitoring programmes in northern Finland.

The present report is also based on information collected from documents referred to in Appendix 1 and from discussions with various persons met during the visit, listed in section 2.4.

The verification team acknowledges the 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

2. PREPARATION AND CONDUCT OF THE VERIFICATION

2.1. PREAMBLE

The Commission services decision to request the conduct of an Article 35 verification was notified to the Finnish Government on 11 December 2006 (letter referenced TREN.H4/CG/cd D(2006) 226565 addressed to the Permanent Representation of Finland to the European Union). The Finnish Government subsequently designated the Finnish Radiation and Nuclear Safety Authority (STUK) to lead the technical preparations for the verification.

2.2. PREPARATORY DOCUMENTS

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

2.3. PROGRAMME OF THE VISIT

EC and STUK discussed and agreed upon a programme of verification activities, based on a Communication by the EC[2], setting out the framework and modalities within which Article 35 verifications may be conducted.

A summary overview of the programme of verification activities is provided in Appendix 2. The verifications were carried out in accordance with the programme.

2.4. REPRESENTATIVES OF THE COMPETENT AUTHORITIES AND THE ASSOCIATED LABORATORIES

During the visit the EC verification team met the following representatives of the national authorities and other parties involved:

Representatives of the Finnish Radiation and Nuclear Safety Authority (STUK)

Name	Title	Area of responsibility
Raimo Mustonen	Deputy Director	Environmental Surveillance
Tarja K. Ikäheimonen	Deputy Director	Quality management
Martti Annanmäki	Quality Manager	Quality management
Kaj Vesterbacka	Head of Laboratory	National external radiation network, airborne radioactivity
Pia Vesterbacka	Head of Laboratory	Radiochemical analyses
Seppo Klemola	Senior Scientist	Gamma spectrometry
Maarit Muikku	Head of Laboratory	Whole-body counting
Ritva Saxén	Senior Scientist	Freshwater, deposition, tap water
Eila Kostiainen	Scientist	Foodstuffs
Petri Smolander	Scientist	Mobile laboratory
Ulla-Maija Hanste	Assistant Researcher	Freshwater, deposition, tap water, foodstuffs
Erkki Ilus	Principal Advisor	Marine monitoring
Mikko Leppänen	Research Engineer	Maintenance of external radiation network

[2] 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 2006/C 155/02).

Santtu Salmelin	Research Engineer	Maintenance of external radiation network
Teija Kekonen	Senior scientist	Chemistry
Pertti Niskala	Assistant research scientist	Gamma measurements and maintenance of the aerosol samplers in northern Finland
Ari-Pekka Leppänen	Head of laboratory	Airborne radioactivity in northern Finland, environmental surveillance

Representatives of the Finnish Meteorological Institute (FMI)

Name	**Title**	**Area of responsibility**
Mikko Alestalo	Deputy Dir. General	
Jussi Paatero	Research Manager	Radiation measurements
Marianne Sågborn		
Juha Hatakka		
Esko Kyrö	Professor	
Veikko Mylläri		
Markku Ahponen		

Representatives of other authorities met during the verification visit

Name	**Title**	**Organisation**
Ilkka Heinonen	Chief of preparedness	Keski-Uusimaa Department for Rescue Services
Keif Johansson		Keski-Uusimaa Department for Rescue Services
Erkki Niemelä		Sodankylä rescue service
Juha Mettiäinen		Pelkosenniemi voluntary rescue service
Marko Koivunen		Savukoski voluntary rescue service
Kimmo Markkanen		Espoo rescue service
Reimo Pöyli		Kemijärvi rescue service
Pekka Särkelä		Kemijärvi rescue service
Minna Sinkkonen		Rovaniemi City Food Laboratory

3. BACKGROUND INFORMATION

3.1. INTRODUCTION

Finland has a nuclear programme, which includes four operational reactors (two in Olkiluoto and two in Loviisa). In addition there is one reactor under construction in Olkiluoto and a small research reactor in operation in Espoo. There are several operational nuclear reactors in the vicinity of Finland, in Russia and Sweden; therefore monitoring of radioactivity in the environment is well justified. Some parts of the Finnish territory received a substantial radioactive deposition from the Chernobyl accident.

The monitoring programme of radioactivity in the environment and foodstuffs does not include radiation from natural radionuclides. Exposure to natural radiation is controlled by a separate programme (indoor radon and natural radionuclides in drinking water), which was not subject to verification in this context.

3.2. MONITORING PROGRAMMES AND RESPONSIBLE ORGANISATIONS

Table I provides an overview of the monitoring programmes in Finland. The following organisations have responsibilities in monitoring radioactivity in the environment in Finland:

3.2.1. Finnish Radiation and Nuclear Safety Authority (STUK)

STUK is a public agency, whose main objective is to prevent and limit the harmful effects of radiation. STUK's regulatory functions cover the use of nuclear energy and all activities that make use of radiation or radioactive substances. STUK carries out research related to ionising and non-ionising radiation and performs the national radiation surveillance in Finland. The number of the staff of STUK is about 350 persons, having a sound competence in the field of STUK's activities. The Act 1069/83 and the Decree 618/97 on Radiation and Nuclear Safety Authority enact the operation of STUK. STUK is operating under the Ministry of Health and Social Affairs.

Environmental surveillance of radiation includes continuous and regular monitoring of radiation or radioactivity in air, soil, water and foodstuffs. On-line surveillance is based on monitoring of external gamma dose rate in a network of 285 automatic stations. STUK maintains and develops emergency preparedness with an aim of ensuring safety of all members of the public and workers in radiological and nuclear emergencies.

Radiological surveillance of foodstuffs is performed by STUK as a part of the surveillance of environmental radiation in Finland. Radioactivity in foodstuffs is also one of the main topics in the research activities of STUK. This research is performed in a number of projects, the focus being in natural food products like mushrooms, wild berries, fish and game meat.

In the case of a radiological emergency STUK is the central laboratory performing radiological surveillance and measurements. There are four regional laboratories (Helsinki, Ylöjärvi, Kuopio and Rovaniemi) which will be activated for more extensive radioactivity measurements depending on the situation. The laboratories in Helsinki and Rovaniemi are STUK's own laboratories; the laboratory in Ylöjärvi is run by PvTT and the laboratory in Kuopio by FMI.

3.2.2. Finnish Defence Forces' Technical Research Centre (PvTT)

PvTT is co-operating with STUK in environmental radiation surveillance by performing monitoring of airborne radioactivity at one monitoring station. In doing that, PvTT uses the collection equipment and analysis software developed by STUK. PvTT is operating under the Ministry of Defence.

3.2.3. Finnish Meteorological Institute (FMI)

FMI performs the surveillance of airborne total beta activity in Finland and carries out several other radiation monitoring activities in parallel with STUK. FMI is operating under the Ministry of Transport and Communication.

3.2.4. Regional environmental laboratories

In Finland there are 40 regional environmental laboratories capable of some basic environmental radiation measurements. These laboratories are not part of the STUK organisation. STUK has provided training and low-resolution (NaI) gamma spectrometers to these laboratories. The spectrometers will be used in the case of a radiological emergency to monitor radioactivity in foodstuffs and drinking water at local level. The laboratories use the spectrometers also for measuring radon in drinking water and performing test measurements according to the instructions of STUK.

Table I. Environmental radiation monitoring programmes in Finland

Media	Monitoring places	Monitored quantity	Frequency	Responsible organisation
Ambient dose rate	285 automatic stations	Dose rate	Continuous	STUK
Airborne radioactivity	Helsinki, Kotka, Imatra, Ylöjärvi, Kuopio, Rovaniemi, Kajaani, Sodankylä, Ivalo	Gamma emitting radionuclides	From 1/day to 1/week	STUK PvTT FMI
Airborne total beta-activity	Helsinki, Virolahti, Nurmijärvi, Tikkakoski, Oulanka, Rovaniemi, Sodankylä, Kevo	Total beta	Once/day or once/week	FMI
Fallout of radionuclides	Helsinki, Kotka, Imatra, Ylöjärvi, Kuopio, Rovaniemi, Kajaani, Sodankylä, Ivalo	Gamma emitting radionuclides, ^{90}Sr	Gamma, 4/year ^{90}Sr, 4/year	STUK
Radionuclides in surface water	Kymijoki, Oulujoki, Kemijoki	Gamma emitting radionuclides	4/year	STUK
Radionuclides in drinking water	Helsinki, Turku, Tampere, Oulu, Rovaniemi	^{3}H, ^{137}Cs, ^{90}Sr	2/year	STUK
Radionuclides in milk	Riihimäki, Joensuu, Jyväskylä, Seinäjoki, Oulu (dairies)	Gamma emitting radionuclides, ^{90}Sr	Gamma, 12/year ^{90}Sr, 4/year	STUK
Radionuclides in foodstuffs	Helsinki, Tampere, Rovaniemi (Main hospitals + foodstuffs on the market)	Gamma emitting radionuclides, ^{90}Sr	2/year	STUK
Radioactivity in the Baltic Sea	19 sampling locations	Gamma emitting radionuclides, ^{90}Sr	1/year	STUK (HELCOM)

4. LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1. LEGALLY BINDING DOCUMENTS

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

- Radiation Act and Radiation Decree (592/91, 1512/91) enacting STUK as the facility to carry out monitoring of environmental radioactivity as described in the Euratom Treaty;
- Act and Decree on STUK (1069/83, 618/97) enacting STUK to monitor radiation in the environment and to maintain preparedness to respond to radiological emergencies;

- EURATOM Treaty, Articles 35 and 36 (1957) enacting EU Member States to monitor environmental radiation in their territories;
- Decree on Rescue Operation (787/2003) enacting STUK and FMI to carry out radiation surveillance in the environment.

4.2. NON-BINDING DOCUMENTS

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

- EU Commission Recommendation 2000/473/EURATOM 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. (EU Official Journal L-191, 27/07/2000);
- HELCOM Recommendation 19/3, Manual for the marine monitoring in the COMBINE programme of HELCOM;
- HELCOM Recommendation 26/3, Monitoring of radioactive substances.

5. NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING

5.1. MONITORING OF EXTERNAL GAMMA DOSE RATE

Finland has an automatic nationwide monitoring network for external gamma dose rate (Figure 1). It has two main functions: alarming and providing an overview of the radiation situation. The network has 285 stations equipped with GM-tubes. The maintenance and development of the network is carried out by STUK in close co-operation with the local civil protection authorities.

STUK is currently renewing the monitoring network. At present almost half of the stations have been renewed. The renewal project will be completed by the end of 2007.

The old network was manufactured by the Finnish company Rados Oy. The manufacturer of the new stations is the German company TechniData AG. The dose rate probes are manufactured by TechniData and Genitron AG.

The new stations have a Linux based computer, which gives the possibility to connect different types of detectors to the station. Currently STUK is using probes equipped with GM-tubes but detectors with nuclide identification capability can be connected to the stations as well. Software for the stations can be either bought from different companies or made in-house.

The new stations have three GM-tubes; two for low dose rates and one for high dose rates. This provides better statistics at background level and allows the system to recognize failures of individual GM-tubes.

The main difference between the old and the new system lies in the data transfer. The new system sends its results automatically in ten minute intervals. Communication is done by using the Finnish secure radio network (VIRVE), dedicated only for authority use. This network is based on the European TETRA (TErrestrial Trunked RAdio) standard. When the new network is completed an overview of the radiation situation will be available almost in real-time for the whole country. Within the VIRVE system also alarming of staff maintaining the measuring equipment is performed and any manual measurement values may be reported.

In the old system, in a normal radiation situation data are collected once a day. In case of an alarm, data are collected from the alarming station and stations situated within approximately 100 km from it. This special mode for alarm cases is no longer needed in the new system.

Data coming from the monitoring stations are managed and presented by the USVA system. USVA is a web-based closed system for STUK, the Finnish Defence Forces, the Finnish Meteorological Institute and the Ministry of Interior. One of the main tasks of the system is to create and distribute a picture of the radiation situation. USVA system will be renewed after the monitoring network renewal has been completed. Monitoring data are stored in a SQL database in 10 minute averages. Results from the old network are checked by software; hourly averages are calculated for the user interface.

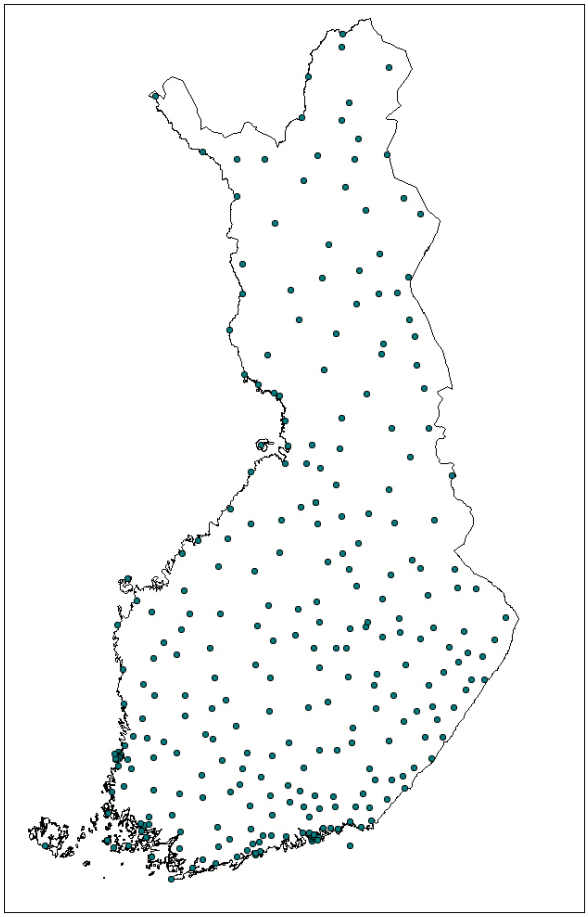

Figure 1. Automatic gamma dose rate monitoring stations in Finland

5.2. MONITORING OF RADIOACTIVITY IN AIR

5.2.1. Air sampling for gamma activity monitoring

STUK operates eight high-volume air sampling stations for nationwide monitoring of airborne radioactive substances. The PvTT has one station. In addition, four samplers are located close to the nuclear power plants in Loviisa and Olkiluoto. Figure 2 presents the locations of the stations.

The air sampler types are the following: Kotka, Kajaani and Rovaniemi have JL-900 'SnowWhite' samplers (air flow rate ~900 m^3/h); Imatra, Kuopio, Sodankylä and Ivalo have JL-150 'Hunter' samplers (~150 m^3/h). The sampler located at the STUK headquarters is the fully automatic model JL-500 'Cinderella' (~500 m^3/h). All samplers are manufactured by the Finnish company Senya Oy. The filter in the Hunter is changed twice a week (Monday and Thursday), in the SnowWhite once a week and in the Cinderella once a day.

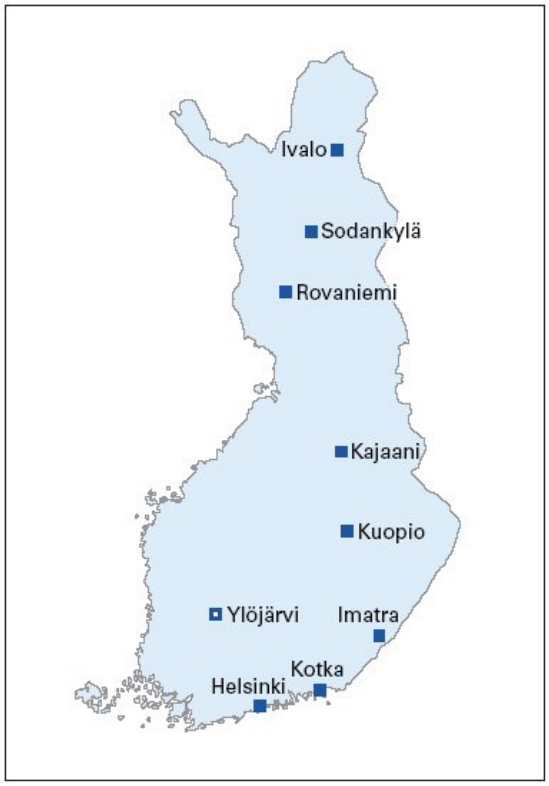

Figure 2. Stations for monitoring airborne radioactivity and atmospheric deposition. The station in Ylöjärvi is operated by the PvTT.

In the air samplers airborne particulate substances are deposited on glass fibre filters; charcoal filters are used for gaseous activity such as iodine. The 'Cinderella' station located in the headquarters of STUK, Helsinki, is fully automated. It filters radioactive substances from the air, changes the filter, prepares the filter for on-site high-resolution gamma spectrometry and reports the data on web pages.

The glass fibre filters from the manual stations are measured with a high-resolution gamma spectrometer in the laboratory. Nuclide specific minimum detectable concentrations ($\mu Bq/m^3$) depend on filtered air volume, the activity of other radionuclides in the sample, the measuring time, the decay time before the measurement, detection efficiency and the background shielding. System detection limits are typically a billion times smaller than the concentrations that may lead to protective actions being taken. The gamma spectrometric analysis method is ISO17025 accredited by FINAS (FINAS T167).

5.2.2. Air sampling for alpha/beta-activity monitoring

As a part of the Finnish national radiation surveillance programme the Finnish Meteorological Institute (FMI) has been measuring beta and alpha radioactivity in air filters and precipitation samples since 1960. In addition to radiation monitoring the results have been used in several meteorological and air quality studies.

Currently FMI collects daily samples at three stations and weekly aerosol samples at eight stations. The locations of the stations are presented in Figure 3.

Daily aerosol samples are collected with high-volume samplers. The filter material is glass fibre (Munktell MGA; Ø 24 cm). The samplers have a capacity of 3500 m^3 per day. They collect particles

with an aerodynamic diameter of less than 10-15 µm. The air flow is measured with a rotameter. The filters are changed daily at 06 UTC.

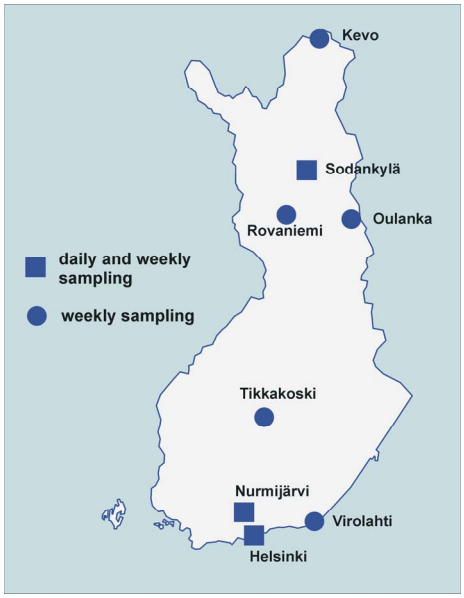

Figure 3. FMI stations for monitoring airborne total alpha/beta-activity

Weekly aerosol samples are obtained from the devices monitoring continuously aerosol beta activity. The equipment uses two rectangular paper filters (Whatman 42) or glass fibre filters (Whatman GF/A) with a filtering area of 120 mm x 140 mm. The weekly air volumes are 800 m^3 and 4000 m^3 for paper and glass fibre filters, respectively. The air flow is measured with a mass flow meter. The filters are changed every Monday at 06 UTC.

All filters are measured in the laboratory with an automatic alpha/beta analyser. The detector arrangement of the instrument consists of five gas flow proportional counters with 25x25 cm windows. Each filter type has its own background sample (an unexposed filter), which is measured at least twice during each measurement sequence. In addition three reference samples (^{242}Pu, ^{90}Sr and ^{55}Fe) are measured at least once during each measurement sequence to monitor the stability of the instrument.

The total alpha and beta activities of all the aerosol samples are measured five days after the end of sampling (when short-lived ^{222}Rn progeny has decayed into ^{210}Pb and the ^{220}Rn progeny into stable lead). The measured net count rates are divided by counting efficiencies and air volumes to obtain total beta activity concentrations. The monitoring results have been published annually since 1991 in FMI and STUK report series.

5.3. MONITORING OF ATMOSPHERIC DEPOSITION

Atmospheric deposition samples are collected continuously at nine sites in Finland (Fig. 2). Samples are taken from the sampling devices usually monthly for the analyses. The collection device is made of stainless steel with a collecting area of 0.07 m^2; it does not separate wet and dry deposition from each other. At two stations STUK has separate sampling devices for tritium determinations. For emergency purposes STUK has at its headquarters one sampler which separates wet and dry deposition from each other. Its collection area is 0.5 m^2.

All the samples are analysed for gamma-emitting radionuclides; ^{90}Sr is analysed on quarterly combined samples. Tritium is analysed on quarterly samples from Helsinki and Rovaniemi. Gamma spectrometry is performed after evaporation and ashing of the samples. An extraction chromatographic

separation method with Sr-specific Eichrom resin is used for the preparation of ^{89,90}Sr-analysis. Sr-measurement is done with a low-background proportional counter.

5.4. MONITORING OF WATER

5.4.1. Surface water

Water from three large rivers (Kymijoki, Oulujoki and Kemijoki), representing three large drainage basins in Finland, is sampled and analysed for radioactivity (Fig. 4). The samples are taken by regional Environment Centres in connection with the samplings for their own purposes four times a year according to the hydrological cycle of the lakes and rivers in Finland. Samples are concentrated by evaporation and ashed thereafter. They are first analysed for gamma-emitters and then for ^{90}Sr. An extraction chromatographic separation method with Sr-specific Eichrom resin is used for the preparation of ^{89,90}Sr-analysis. Sr-measurement is done with a low-background proportional counter.

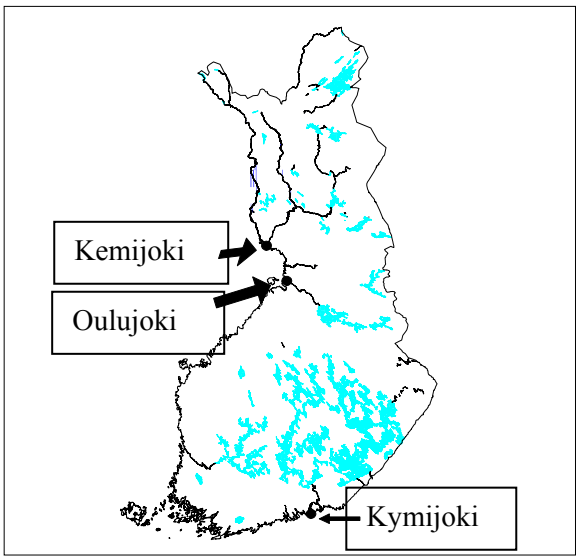

Figure 4. Discharge points of the three rivers belonging to the surveillance programme

5.4.2. Drinking water

Both ground water and surface water are used for drinking in Finland. Drinking water samples are taken twice a year from five sites in Finland: Helsinki, Tampere, Rovaniemi, Oulu and Turku. In three places (Helsinki, Tampere, Rovaniemi) samples are taken directly from the tap in connection with the sampling of mixed diet samples. In two places (Oulu and Turku) samples are taken by water treatment plants and delivered to STUK.

Gamma-emitters, ^{90}Sr and tritium are determined on the samples. A subsample from each of the samples is taken first for the tritium determination. Tritium is determined after distillation by measuring directly with a liquid scintillation spectrometer. The samples are concentrated by evaporation and ashed to remove organic material. Gamma-emitters are determined with semiconductor detectors. An extraction chromatographic separation method with Sr-specific Eichrom resin is used for the preparation of ^{89,90}Sr-analysis. Sr-measurement is done with a low-background proportional counter.

5.5. MONITORING OF SOIL AND BIOTA

No soil sampling is included in the national surveillance programme in Finland. Terrestrial and aquatic biota and flora are collected and monitored on a regular basis only in the surroundings of the domestic nuclear power plants and in the Baltic Sea (section 5.7).

5.6. MONITORING OF FOOD

5.6.1. Milk

Milk is sampled from five dairies (Joensuu, Jyväskylä, Oulu, Riihimäki and Seinäjoki) located across the country representing different production conditions (Figure 5). Weekly samples (1 litre/week) from each sampling site are taken during one or two days in the dairy. The samples are sent to STUK weekly or monthly.

Weekly samples are frozen and bulked for a monthly analysis. Monthly samples (4-5 litres) are evaporated and ashed before analysis. ^{137}Cs and ^{40}K are determined by gamma spectrometric measurement on the ashed samples. ^{90}Sr is determined from quarterly bulked samples by separating strontium (extraction chromatographic method and thereafter measurement of ^{90}Sr with a liquid scintillation spectrometer).

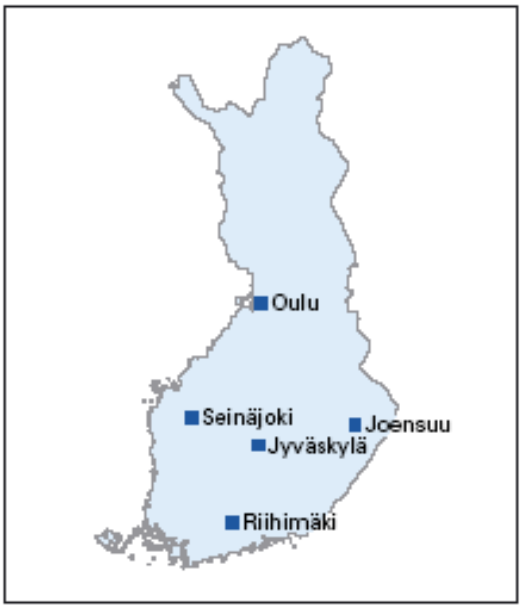

Figure 5. Sampling sites for milk monitoring

5.6.2. Mixed diet

Mixed diet samples are collected twice a year at institutional kitchens in Helsinki, Tampere and Rovaniemi. The kitchens collect all the meals including bread and beverages during one day, drinks and solid food separately.

All the meals of the sampling day as well as the drinks are bulked together before analysis. ^{137}Cs is determined by gamma spectrometric measurement on the ashed samples. ^{90}Sr is determined from food and drink samples by separating strontium (extraction chromatographic method) and thereafter measuring ^{90}Sr with a liquid scintillation spectrometer.

5.6.3. Other foodstuffs

The national programme for sampling other foodstuffs includes sampling of pork, beef, potato, vegetables, reindeer meat, venison, wild mushrooms, wild berries and fish. When available, also wild animal meat can be included in the programme.

Typically 2-10 samples of each type of foodstuff are taken from food shops and market places at three sampling sites (Helsinki, Tampere and Rovaniemi) every autumn. ^{137}Cs is determined by gamma spectrometric measurement on dried samples.

5.7. MONITORING OF RADIOACTIVITY IN THE BALTIC SEA

All the Baltic Sea States have ratified the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention). The Helsinki Commission (HELCOM) co-ordinates the implementation of the Convention. Recommendation 26/3 of HELCOM defines the programme for monitoring the occurrence, transport and amounts of radionuclides in the Baltic Sea. All the Baltic Sea States contribute to the monitoring with their own national programmes. The monitoring areas of the national programmes are not restricted to territorial waters and in several areas they overlap each other for comparison purposes.

The Finnish contribution consists of about 120 annual samples from seawater, bottom sediments, fish and other biota, analysis of radioactive substances and reporting of the results to the HELCOM database. STUK is responsible for the Finnish part of the programme. The results are published in joint reports every five years. In addition, STUK maintains a discharge register, to which the Contracting Parties report annually discharge data from all nuclear facilities operating in the Baltic Sea area.

The sampling locations for seawater, bottom sediments, fish and other biota are shown in Figure 6. Seawater samples (26) are taken once a year from 15 sampling locations, sediment samples (entire depth profile) from 6 locations, fish (pike and Baltic herring) from 6 sampling areas and other biota (*Fucus vesiculosus, Macoma baltica and Saduria entomon*; 3 samples) from 2 sampling areas. The samples are taken onboard of the Finnish research vessel *Aranda*, or in the coastal areas by the staff of STUK or local fishermen.

The methods used in sampling, pre-treatment and analysis are ISO 17025 accredited by FINAS and described in the Quality Manuals of STUK. Seawater samples (30 litres) are taken with large seawater samplers, sediment samples with a Gemini Twin Core sampler, fish samples with fishing nets, *Fucus* samples by scuba diving and the bottom animal samples *(Saduria* and *Macoma)* with bait nets or bottom grabs. The nominal sampling quantities are 5 kg fresh weight for fish, 2 kg for *Fucus*, and 200 g for *Macoma* and *Saduria*.

The radionuclides to be analysed are defined in the guidelines of HELCOM Recommendation 26/3 (Table 2). The results are stored in LIMS database at STUK, and reported annually to the HELCOM database.

1. Station LaV 4 (W)
2. Station CVI (W + S)
3. Hailuoto (F)
4. Station BO 3 (W)
5.Station F 16 (W)
6. Vaasa (F)
7. Station US 5b (W)
8. The Olkiluoto area (W + B)
9. Station EB 1 (W + S)
10. Seili (F)
11. Tvärminne (F)
12. Pernaja R1 (W)
13. The Loviisa area (W + F + B)
14. Station LL 3a (W + S)
15. Station LL 7 (W)
16. Station JML (W+S)
17. Station LL 17 (W+S)
18. Station BY 15 (W + S)
19. Station BY 2 (W)

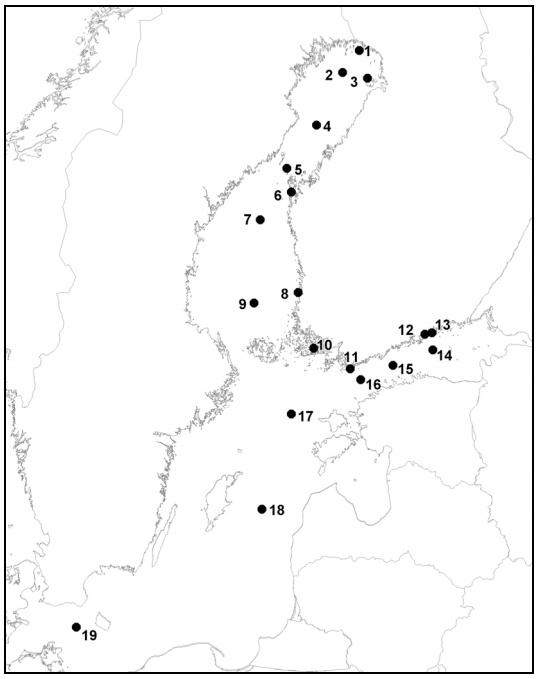

Figure 6. Marine sampling locations for sea water (W), bottom sediment (S), fish (F) and other biota (B)

Table 2. Radionuclides to be monitored according to HELCOM Recommendation 26/3

SAMPLE	OBLIGATORY	VOLUNTARY
A. Water (Bq/m^3)	Radiocesium* ^{90}Sr**	^{3}H; ^{99}Tc; ^{239}Pu; ^{240,241}Am; γ-emitters
B. Sediments (Bq/kg dry wt. and Bq/m^2)	γ-emitters***	^{90}Sr; ^{239}Pu, ^{240,241}Am; natural radionuclides (e.g. ^{210}Po)
C. Fish (Bq/kg fresh wt.)	γ-emitters***	^{90}Sr; natural radionuclides (e.g. ^{210}Po)
D. Aquatic plants (Bq/kg dry wt.)	γ-emitters***	^{90}Sr; ^{99}Tc; ^{239}Pu, $^{240, 241}$Am; natural radionuclides
E. Benthic animals (Bq/kg dry wt.)	γ-emitters***	^{90}Sr; ^{99}Tc; natural radionuclides (e.g. ^{210}Po); $^{239, 240}$Pu; ^{24}Am

* ^{137}Cs and ^{134}Cs, if possible
** regularly on a selected number of samples
*** ^{40}K, ^{137}Cs and other γ-emitters identified in the γ-spectrum

5.8. MOBILE MEASUREMENT SYSTEMS

For radiological emergencies, STUK has a mobile laboratory, which has state of the art automatic range tracking (ART), measurement, sampling, positioning and communication equipment. Measurement and analysis results are available at STUK almost in real time.

5.9. OTHER ENVIRONMENTAL MONITORING ACTIVITY

For real or suspected emergency situations FMI maintains a capability to carry out radioactivity balloon soundings of the atmosphere. In addition it is possible to carry out airborne plume air sampling using the equipment of the Finnish Air Force.

6. VERIFICATION ACTIVITIES

6.1. INTRODUCTION

In accordance with the agreed verification programme, the verification team visited the following locations:

- **STUK Headquarters, Helsinki**

- Air monitoring systems
- Fallout sampling systems
- Filter sample archive
- Mobile measurement systems
- Marine sampling systems
- Results database

- **FMI laboratories, Helsinki and Sodankylä**

- Air sampling systems
- Filter sample archive
- Radioactivity laboratory
- FMI observatory (Sodankylä)

- **Keski-Uusimaa Rescue Department, Vantaa**

- Automatic dose rate measurement system
- Alarm centre

- **STUK Regional laboratory, Rovaniemi**

- Air monitoring systems
- Fallout sampling systems
- Radioactivity laboratory
- Chemistry laboratory
- Emergency preparedness office

- **Automatic dose rate measurement stations**

- Espoo
- Sodankylä
- Savukoski
- Pelkosenniemi

- Kemijärvi
- Kotala
- Salla

- **Rovaniemi City Food Laboratory**

6.2. STUK HEADQUARTERS IN HELSINKI

6.2.1. General

At the opening meeting STUK presented the Finnish environmental radioactivity monitoring arrangements, relevant legal texts and associated laboratories. STUK is the central organisation in charge of the programme and the competent authority towards the European Union requirements in the area. It compiles an annual report of the measurement results. STUK has an ISO 9001 quality system in place and its laboratories are accredited to ISO 17025 standard.

The verification team was informed that in addition to the national programme STUK carries out also the environmental monitoring programmes around the nuclear power plants in Finland. In this work STUK has the role of a contractor for the nuclear power utilities. This arrangement raises the question of independence of monitoring, since STUK acts both as a measurement contractor and a regulatory authority. The issue has been tackled by making sure the contractor and regulatory services are strictly separated within the STUK organisation. Even with these arrangements in place the situation is not fully compliant with the requirements of independence and transparency. However, taking into account the limitations of expert staff and suitable laboratory resources, the situation can be understood.

> *Verification does not give rise to recommendations. However, the verification team points out that the role of STUK as an environmental measurement contractor for the nuclear power utilities and a regulatory authority is problematic from the point of view of independence and transparency.*

6.2.2. Fallout sampling systems

The verification team verified the atmospheric fallout deposition sampler "Pirkko", located on the roof of the STUK headquarters. The sampler has an automatic rain detection system and therefore it is able to distinguish between dry and wet deposition.

> *Verification does not give rise to recommendations. The verification team acknowledges the unique capability to separate dry and wet deposition.*

6.2.3. Air sampling systems

The verification team verified the automatic high-volume air sampler "Cinderella", also located at the roof of the STUK headquarters. Cinderella is a very sophisticated monitoring system, which carries out sampling and filter analysis completely automatically. Measurement and system control results are placed on the LINSSI-database. The filter paper (Whatman) is changed at 10 AM each morning and cut by a robot to 15 small squares, which are stacked together and measured by gamma spectroscopy (electrically cooled HPGe) after a 24 h cooling time for radon decay. Counting time is also 24 hours. System nominal air volume is 180 m^3/h and there is an on-line flowmeter (no pressure correction) for flow determination. There is no routine calibration scheme for the flow meter, but a recalibration is scheduled to take place soon. There is no automatic alerting for low flow in the system.

Efficiency calibration of the Cinderella analysis has been established using a multinuclide standard source; also Monte Carlo calculations have been used. A 10 minute control measurement for FWHM

and peak stability is carried out automatically on a daily basis using a ^{60}Co source and recorded for quality assurance purposes.

The Cinderella system is continuously in operation; altogether 5 persons have been trained to operate the system. Electrical back-up for the PC and the robot is provided by a local UPS, pump electrical back-up is supplied by the building electrical back-up diesels (30 second start-up time).

Verification team performed a sample trace of filter HEPO2CIOIP from 15 March 2007. All records were found on paper and on a CD.

Verification does not give rise to recommendations. The verification team suggests implementation of a low-flow alert in order to detect malfunctions as early as possible.

6.2.4. Mobile measurement systems

STUK has a mobile monitoring laboratory called SONNI. The mobile equipment is mainly used for emergency monitoring purposes, but possible other applications include complimentary environmental measurements and radiological surveillance for example in major public events.

The main mobile tool is a 4x4 van equipped with the following systems:

- Ambient gamma dose rate measurement equipment;
- In-situ gamma spectroscopy equipment (a large NaI detector and an electrically cooled HPGe detector (40% relative efficiency));
- 2 air sampling systems with flowmeters, which are able to sample about 40 m^3 per hour depending on vehicle speed and wind;
- Alpha-beta spectroscopy equipment (without chemical treatments);
- Data management systems with GPS positioning for transferring data to the LINSSI-database (GPRS).

When the mobile laboratory is operated in the field it usually has a 4 person crew. The systems have advanced automation, so the operating personnel do not need to be trained on expert level. This allows STUK to have a pool of staff trained for mobile operation.

The mobile equipment base at STUK includes also equipment for three 2-person foot patrols, equipped to carry out gamma dose rate and beta activity measurements and air sampling using portable air samplers (airflow 10 m^3 per hour). There is also a possibility to perform iodine assessment on thyroid and milk using portable gamma spectroscopy systems.

In addition to its own mobile equipment STUK has an agreement with the Finnish Defence Forces to assign helicopters for airborne gamma monitoring or jet aeroplanes for airborne plume sampling. There is no formal stand-by arrangement for these measurements, but according to STUK staff not more that one day would be needed in order to initiate airborne measurements in the event of an emergency.

Verification does not give rise to recommendations.

6.2.5. Marine monitoring systems

The verification team verified the arrangements for carrying out marine sampling and analysis (sea water, sediments, fish and vegetation) in order to fulfil the requirements of the Baltic Sea monitoring programme. Sampling is done according to HELCOM methodology, mostly from the Finnish marine institute research vessel Aranda. The programme is carried out in collaboration with the Ministry of Environment. There is an annual reporting mechanism of results, including dose calculations, to the HELCOM database.

The team verified the STUK sediment sampler, type Gemini, and the associated sample slicing equipment. With these it is possible to collect sediment sample cores of 8 cm diameter from a maximum depth of 60 meters and slice the samples in 1 cm slices for laboratory measurements. Ashed samples are kept for a few years.

Marine measurements have been subject to several intercomparison exercises organised by the HELCOM MORS group. Most of these exercises are coordinated by the IAEA Marine Laboratory.

Verification does not give rise to recommendations. The team acknowledges the extent and international coordination of the marine monitoring programme of the Baltic Sea.

6.2.6. Filter archive

Filter papers from the STUK high-volume air sampling systems are kept in a storage room at the STUK headquarters. Each filter is archived in a plastic bag with a label identifying the sampling time and sampled air volume. Filters are kept indefinitely, but there is no documented procedure on sample archiving.

Verification does not give rise to recommendations. The verification team suggests defining and documenting a sample archiving policy as a part of the laboratory quality system.

6.2.7. Analytical laboratory

The STUK analytical laboratories are housed in the central part of the STUK building. They are specially ventilated and certain areas are made of specially chosen construction materials.

Work in the laboratories is arranged so that experienced staff and 'new' colleagues are working in parallel. Aim of this internal organisation is to better manage scientific and routine programmes. However, the verification team had the impression that some staff members were a little 'uneasy' about the prospect of having to do rather routine chores as compared to 'exciting' scientific work. To avoid negative effects, STUK intends to leave method development tasks within the 'routine' work; thus the associated risk of staff demotivation should be low.

The verification team suggests re-examining the mid- and long-term effects of the ongoing work re-distribution with a view to check that no 'demotivation' of staff doing predominantly routine work is built up.

Environmental sample registration

STUK routinely uses a Laboratory Information Management System (LIMS) and in parallel does also manual registration of samples. The electronic registration is being expanded also to old sample records by including old manual records in the LIMS system.

The identifier given at the registration consists of sample code, a running number and the sampling year. A written procedure for registration tasks is in place. Within LIMS the registrar's name is included via the login name. All sample data including sample preparation method, results etc., are stored.

The current LIMS is web based and contains also a descriptive part with a list of sampling locations, analytical laboratories etc. The sampling guide itself is not included in the LIMS but it is available in the web-based laboratory manual. Changing old sampling information conserves the history of data input i.e. providing full data transparency.

Verification does not give rise to recommendations.

Environmental sample preparation

Samples generally arrive weekly or monthly. They are combined into monthly samples and deep frozen if useful. The verification team was shown such samples. The sample descriptions contain the sampling location and the week number.

Sample evaporation in 10 litre bowls under infrared lamps takes several days. Plastic foil material used for protection in this operation has been tested and shows no radioactivity; there is no residue when ashed.

Low radioactivity samples (e.g. milk) and higher level samples (e.g. fish, soil) are kept separated and prepared using different tools in order to avoid cross-contamination. Written sampling procedures are available and all sample preparation steps are documented in the laboratory logbook, which contains also the measurement results.

Verification does not give rise to recommendations.

Gamma spectrometry

STUK operates two separated gamma counting rooms. Altogether there are two scientists and 4 assistants in charge of measurements. Sample distribution to the two rooms depends on the availability of detectors. Sample descriptions are in the LIMS and marked on the sample; measurement results go into the LIMS. The physical samples are returned to the sample preparation unit after counting.

The verification team visited one of the gamma spectrometry rooms. Seven detectors (Ortec, Canberra, all low background versions) are operated using NIM electronics from Ortec and Canberra. The shields are 10 cm Pb with Cu lining; flushing with nitrogen evaporating from LN_2 cooling was being tested but not seen as being very important.

STUK and all associated laboratories (i.e. laboratories that are included in the national monitoring) currently use STUK software Gamma-99 for the spectrum analysis and Ortec Maestro for spectrum acquisition. Gamma-99 software is accredited but it cannot be further developed. Thus it is foreseen to switch to the Linux based gamma software package SAMPO. A co-operation exists between STUK, the Technical University of Helsinki (the original developers of the system) and the Canadian Health Authority for further system development. Also four regional labs (including Rovaniemi) will have the license for the SAMPO software.

The Gamma-99 software has a possibility for inter-active analysis; selected data are electronically transferred to LIMS. Three definitions for the detection limit are available.

Efficiency calibrations are available for 8 cylindrical geometries and Marinelli beakers. In cylindrical geometries sample height is variable and taken into consideration by the analysis software. Density correction is also applied.

The laboratory does calibration check in every spectrum using naturally occurring peaks and graph plots. Full system recalibration is performed every five years. There is no automatic alarm when deviations occur. In addition recalibration is performed whenever a new detector is set in operation. This happens approximately every 3 years. Calibration sources are from Amersham, NIST etc. and have to be traceable to a known standard. STUK buys the standard solutions and laboratory chemists produce the calibration standards. Procedural tests use reference materials from IAEA inter-comparisons, NPL (National Measurement Laboratory, UK) and analysed air filters.

Background spectra are acquired about 4 times per year and kept in a "background file" for any re-evaluation.

There is no maintenance contract for the measuring devices. UPS systems in both counting rooms allow for operation during power breaks for up to 1 ½ hours. During that time a diesel power generator can be switched on for continued operation. LN_2 is supplied once a week from a contracted supplier.

The verification team traced a milk sample from 31 March 2005 (sample from Oulu). All information could be retrieved, including spectrum and log files.

Verification does not give rise to recommendations.

Beta measurements

For beta measurements three counting rooms are available.

For the determination of ^{90}Sr in milk a method with ion extraction chromatographic separation (EICHROM) is used. The procedure document is available at the laboratory. Five technicians and seven radio-chemists have been trained for this task. A replacement system for the personnel (in particular for emergencies) has been defined.

Measurement of beta emitters is carried out either by LSC (^{90}Sr, normal for milk; three LKB/Perkin-Elmer Quantulus devices) or with a low level counter (Y, normal for deposition; one Risø GM-25-5 device with 25 counting places, GM tubes with Ar-Isobutane filling). Background water for tritium determination comes from the Geological Institute of Finland. An old Berthold LB770-1 proportional counter device is kept available for emergencies.

Quality control is done manually on control sheets based on background and reference sample measurements. The laboratory participates in intercomparisons and uses IAEA reference materials for procedure development purposes.

Verification does not give rise to recommendations.

Alpha measurements

STUK bases its alpha emitter determinations on ion exchange plus alpha spectrometry, using a home made electrodeposition system. The current measurement programme contains Pu determinations in the Baltic Sea, NPP and research samples. A new procedure (EICHROM™) is applied. A micro wave furnace is available for breaking the sample matrix. The procedures are standardised and well described.

Alpha spectrometry is done using an Alpha Analyst system with 2x6 chambers. Canberra Alpha Analyst software is used for spectrum acquisition and analysis including quality control. Data are transferred to PC and then to LIMS. In addition, all staff involved has to know the manual analysis method. The selection of the detectors (for various applications) is described in the lab manual taking into account recoil effects.

For higher activity samples three LKB Wallac 1414 Guardian liquid scintillation counters with QC software are available.

Verification does not give rise to recommendations.

Other samples

The verification team visited the treatment room for higher activities, usually originating from the NPPs. ^{14}C and ^{3}H are determined only in NPP samples. A possibility for including these radionuclides in the research programmes exist. Currently tritium is determined only as HTO not as OBT. Sample preparation follows a chart which makes the task easy to take over by another staff member.

Verification does not give rise to recommendations.

Whole Body Counting

Due to the fallout from the atmospheric nuclear weapons testing and Chernobyl accident human whole body counting is viewed as an official monitoring task in Finland. Altogether some 400 - 500 persons are measured annually. About 150 persons are measured in the framework of the monitoring program. The monitoring program includes annual measurements of children and teachers from local schools and persons working at STUK in Helsinki, Rovaniemi and Tampere. Schools were chosen because different age groups are easily available among schoolchildren and teachers. All persons measured are volunteers.

STUK has agreements with 15 hospitals as local thyroid measuring points in case of emergencies to be able to manage also much larger number of measurements.

There are two whole-body counting systems at STUK. One is a permanently installed in the laboratory in Helsinki and the other is a mobile unit. The fixed installation currently is built up from 4 NaI(Tl) and 3 HPGe detectors. 80 tons of steel and lead supply background shielding. The client lies on a moving bed. A new mobile unit was equipped for whole-body counting in the beginning of year 2007. The mobile system includes a measurement chair with two sensitive HPGe -gamma detectors.

Calibration is done using the so-called IGOR phantom (weight ca. 100 kg). QA is performed daily with a reference source. The measurement is accredited and subject to an annual accreditation control.

Currently tests with a broad energy germanium detector are performed for determination of natural uranium in skeleton due to uptake by drinking water. Furthermore, plans exist to reorganise the measurement room to be suitable also for longer measurements.

Verification does not give rise to recommendations.

6.2.8. Monitoring results database

The verification team witnessed a demonstration of the LINSSI-database for storing measurement data from the STUK monitoring systems. The database is used for all measurement data, including on-line data from the mobile systems. The database allows an automatic analysis of data using programmes SHAMAN and UniSAMPO; a manual reanalysis is also possible.

Verification does not give rise to recommendations.

6.3. FINNISH METEOROLOGICAL INSTITUTE

6.3.1. General

Air radioactivity measurements are a traditional research area of FMI, although the main research focus today is elsewhere. FMI maintains a considerable equipment base for measuring total beta activity in air. It provides STUK with atmospheric dispersion modelling on a 24 h basis for emergency preparedness purposes using the SILAM modelling system. The system is operational in the European area; it is capable of performing also backward dispersion calculations.

6.3.2. Air sampling

FMI has several air sampling stations where continuous monitoring of beta activity is carried out. There are also daily air aerosol samplings for Beryllium determination and automatic alpha/beta analysers.

The verification team verified the high-volume air sampling system located at the roof of the FMI building in Helsinki. The system is equipped with a flow meter and a MGA-type glass fibre filter, which is changed daily. Daily sampling volume is about 3500 m^3.

Verification does not give rise to recommendations.

6.3.3. Deposition sampling

The verification team verified the large heated deposition sampler, also located on the roof of the FMI building. This device is not part of the routine monitoring programme, but it is available for emergency monitoring purposes.

Verification does not give rise to recommendations.

6.3.4. Beta activity and dose rate monitoring

For continuous air beta activity monitoring the FMI operates a system based on a two GM-counters wrapped with a filter paper. The system has two pumps, two detectors and an air flow meter. Data are collected by a PC and transferred daily to a central server. In case of abnormally high readings an alert is sent to the FMI duty staff. This type of system has been operational on a continuous basis at FMI from the 1960's, so the institute has a very long experience in this type of surveillance.

At the same location FMI operates also a NaI(Tl) detector based gamma dose rate measurement system, which is able to distinguish between ambient and deposition dose rate. Calibration of the system is performed monthly.

A UPS with 30 minute electrical back-up capability is provided for the equipment. Generally the measurement equipment is fairly old, but in good condition and functional.

Verification does not give rise to recommendations.

6.3.5. Sample archive

The FMI sample archive houses a very extensive and complete collection of air filters since the 1960's. The archive is in excellent order and each filter paper has a bar code identifier. The verification team noted that the small archive room has a water based fire sprinkler system, which could cause significant damage to the archive if activated for any reason.

Verification does not give rise to recommendations. The team notes that the FMI air filter paper archive represents a significant scientific value and therefore it is very important to ensure its physical integrity.

6.3.6. Radioactivity laboratory

The verification team visited the FMI radioactivity laboratory, which is located under a water pool in order to reduce background radiation. The laboratory has Ortec (n-type 40%) and Canberra (30%) HPGe-gamma spectrometry systems for measuring air filters.

Gamma spectroscopy systems are calibrated for efficiency using a multinuclide standard provided by STUK. Regular control for peak energy and width (FWHM) is carried out, but there is no formalised policy for these controls. Laboratory background radiation is measured on a regular basis.

There is also an alpha-beta anticoincidence analyser, which is used to measure all FMI air filters. The system is equipped with an automatic sample changer mechanism and a bar code reader for sample identification. The number of measurements carried out is quite high since each filter is measured three times: when received at the laboratory (surveillance), after 5 days (long-lived nuclides) and after 6 months (^{210}Pb determination). Typical counting time is 30 minutes.

The FMI laboratory is not accredited for radioactivity measurements.

Verification does not give rise to recommendations. The verification team suggests that the laboratory should proceed towards a formal accreditation and establish a formalised system for detector calibration and stability control.

6.3.7. Sodankylä observatory

The verification team visited the FMI observatory in Northern Finland, which is located in Tähtelä, close to the city of Sodankylä. The site has a large collection of atmospheric and meteorological instruments, among them instruments for monitoring airborne radioactivity and ambient dose rate. Airborne radioactivity measurements have been performed on this site on a continuous basis since the 1960's.

The site operates a high volume air sampler (Hunter) owned by STUK. The particulate filter of this device is changed weekly and the charcoal filter for iodine measurements monthly. The samples are shipped to STUK laboratory at Rovaniemi for gamma analysis.

Continuous beta activity monitoring is carried out using a similar equipment set-up as in the Helsinki laboratory. Data transfer to Helsinki in done in real time.

Continuous gamma dose rate is measured using a similar equipment set-up as in Helsinki; i.e. the system is able to separate deposition and ambient dose rate.

Verification does not give rise to recommendations.

6.3.8. Other verification items

The verification team was informed that the FMI maintains a capability to perform GPS-based radioactivity (dose rate) soundings of the atmosphere using balloons sent from its measurement stations. These soundings are not part of the routine programme, but they are exercised on an annual basis in order to maintain the sounding capability for emergency situations. Usually about 10 radiosondes are kept in storage on each sounding station for the possible need in an emergency situation.

Verification does not give rise to recommendations.

6.4. NATIONAL AUTOMATIC ENVIRONMENTAL RADIATION MONITORING NETWORK

6.4.1. General

The verification team was informed about the currently ongoing project to modernise the automatic radiation dose rate monitoring network in Finland. During the verification visit the modernisation process already covered southern and central Finland; stations in the northern part of the country will be replaced with new ones by the end of 2007.

The general procedure for setting up new equipment is that after arrival of a new station from the producer the software is installed by STUK. Then the devices are transported to the respective sites and a contractor installs the device in the selected location. When completed, Finland will have a very modern and sophisticated automatic dose rate measurement network, which has very good technical characteristics to function also during emergency situations, extreme weather conditions and power black-outs.

Some of the old stations will not be replaced and some may be moved to other sites. The total network size will reduce by approximately 10-15 monitoring stations. The number of monitoring stations after renewal is 253 and STUK plans to increase the number to 260 stations within a few years.

The new network informs the STUK expert on duty if the 1-minute value on any station exceeds 0.4 μSv/h. If the 10-minute value exceeds 0.4 μSv/h a local alarm and an alarm in the STUK emergency response centre is generated. Alarm is also sent from alarming station to emergency response centre, which acts as a back-up organization for dose rate alarms. All necessary software has been written by STUK (using MySQL data base). Data flow has a backup by different methods (e.g. text messages).

The verification team was informed that the siting policy for the new stations was to locate them at local fire departments and other places which are staffed on a daily, if not 24 h, basis. In northern Finland this seems problematic, since not all old stations fulfil this criterion.

The verification team recommends adapting the new network siting criteria in northern Finland in order to avoid reducing the number of automatic monitoring stations in the area.

6.4.2. Network data centre

For managing and presenting data from the on-line ambient dose rate monitoring system (together with the possibility of presentation of some additional information) STUK runs the USVA system. It is a web based system (https), originally designed as Y2K solution. There are plans for a renewal; the new presentation system is foreseen at the earliest in 2008. Work on it will be probably mostly done at STUK.

From the old network 10 minute results are fetched by public telephone lines. In the new system data will be transmitted every 10 minutes. On the displayed maps old stations are shown as black and white dots, new in colour. The system is rather slow and has fixed zoom levels. Information on the station selected is available.

Trend information based on a simple Gaussian test is shown in quick view as colour code (green – improving; red – deteriorating; yellow – stable).

Other types of presentation are: averages over municipality (if no data are available an extrapolation from surrounding sites is performed); trajectories (supplied by FMI); synoptic information (wind direction etc.). The system also presents some data from outside Finland: Norway, Sweden and Russia (Russian data are supplied bilaterally, based on good relations; transmission is once per day by satellite phone). STUK is also the Finnish counterpart in the European EURDEP data platform.

The verification team noted that at the time of the visit some stations in northern Finland did not work. It was informed that these will not be fixed because of foreseen replacement in the following summer.

For emergency purposes STUK has installed the decision support tool RODOS. Numerical values from the SILAM meteorological system as well as data from the dose rate monitoring system are saved in a data base and are available for comparison. Besides RODOS, STUK operates the VALMA model for dose and activity concentration calculations. Real data assimilation (i.e. taking measurement data into the system and proceeding with measured instead of calculated values) is not yet possible.

STUK plans to participate in a PTB intercomparison exercise for dose rate systems in 2008.

Verification does not give rise to recommendations. The verification team encourages participation in intercomparison exercises.

6.4.3. Vantaa rescue station

The verification team verified the ambient gamma dose rate measurement station located at the rescue station close to the Helsinki-Vantaa airport. This station is one of the new generation stations. The detector probe (TechniData 3-chamber, type IGS421A/B-H) is located next to the heated rain detector

on the grass lawn outside the Rescue Department building and the associated dose rate display unit inside the building at the Department alarm centre. The system provides a sound alert in the event of high readings; data are transmitted over the digital VIRVE network to the STUK data centre. The system has EMP shielding and a 72 h power back-up.

Verification does not give rise to recommendations.

6.4.4. Espoo rescue station

The dose rate monitoring station in Espoo is part of the new system. It uses a TechniData device (IGS421A1-H) with a rain status information device TechniData RD203.

The probe is situated several meters from trees and the building; it is mounted 2 m above ground (the reason for not mounting at 1 m height being possible high snow cover).

The detector itself is built up from three GM tubes (2 for low dose rate, 1 for high dose rate). The pulse rate from each tube is collected every minute; if one of the low dose rate detectors fails a flag is set (and later on transmitted to the centre), but the device is still operational.

The verification team was shown the external display in the control room which gives an easy possibility to communicate measurement values in case the automatic data transmission breaks down. In addition the fire brigade has a portable dose rate meter and a portable VIRVE device for communication if needed.

The verification team was informed that every 5 years a maintenance by STUK is foreseen. This would include checks with a calibration source, checks of the alarm path and hardware changes if needed (e.g. power supply).

The verification team was shown the devices for data logging and communication situated in the garage. The system includes TechniData Envilog with internal display, Linux based computer with touchpad, battery back-up for 72 hours and a VIRVE modem for data transmission. STUK can connect to the computer to fix problems or upgrade software. There is a possibility to connect a 'normal' modem if needed. All devices are lightning protected.

Verification does not give rise to recommendations. However the team – taking into account that the snow cover in that area generally is not a limiting factor – suggests mounting the detector at one metre above ground when an opportunity arises.

6.4.5. Sodankylä rescue station

The verification team verified the gamma dose rate monitoring station at the Sodankylä rescue station. Originally there had been four stations in the Sodankylä area, but currently only three are operational. Due to the 24 h presence requirement of the siting criteria the plan is to have only two modernised stations in Sodankylä in the future.

The equipment at the rescue station has not yet been modernised, so it has the old AAM type dose rate probe. Dose rate monitor and detector electronics are located in the basement of the rescue station where the local alarm centre is located. Data are transferred to the STUK data centre via a telephone modem.

AAM type stations do not have built-in battery back-up, but in Sodankylä there is an emergency diesel generator available to provide electrical power during power cuts.

Verification does not give rise to recommendations.

6.4.6. Pelkosenniemi rescue station

The verification team verified the AAM station at Pelkosenniemi. The detector is located on the roof of the local fire department; detector electronics and a local display are inside the building in a small communications room.

Verification does not give rise to recommendations.

6.4.7. Kotala school

The dose rate monitoring station at Kotala is of the 'old' AAM type and probably will be closed. A new one is planned several kilometres away at the frontier to Russia at the customs office.

The detector (Rados) is mounted on a high pole amidst a small forest, between high trees. The monitor with a local display (Rados RDS-120; battery NP12-12) and the data transmission device (Alnor) are mounted in the kitchen of the nearby closed school building. The station is serviced by personnel from the Salla fire department (ca. 30 km distant).

The verification team saw that a local alternative for mounting the device (besides the flagpole) would seem possible if the detector should have to stay.

The verification recommends to mount the detector in a more suitable location should the device stay at Kotala.

6.4.8. Salla rescue station

The dose rate monitoring station at Salla is of the 'old' AAM type and probably will be replaced. The detector (Rados) is well located in a small meadow, some 10 m from a two storage building and some 15 m from trees. The mounting height is approximately 2.5 m. Altogether three persons are employed at the station. The monitor with a local display (Rados RDS-200; battery backup) and the data transmission device (Alnor, US Robotics Courier modem) are mounted in the office of the fire brigade building.

Verification does not give rise to recommendations.

6.4.9. Kemijärvi rescue station

The dose rate monitoring station at Kemijärvi is of the 'old' AAM type. The equipment will be replaced in the near future.

The detector (Rados) is located outside the town centre, on a small hill, near a small copse, close to young trees some 10 m from a building. The mounting height is approximately 2 m.

The monitor with a local display (Rados RDS-200) and the data transmission device (Alnor, data transmission twice a day) are mounted on a wall in the office of the fire brigade building. Local alarm is possible. Contact information sheets and manuals were shown to the verification team. If necessary also hand-held dose rate monitors (e.g. Alnor RDS120) are available for measurements.

Altogether four professional firemen and 20 volunteers are engaged at the station. Manning is from 8 am to 4 pm, outside service hours contact is by the VIRVE system (24/7).

The verification recommends to regularly cut any trees growing close to the detector and to reconsider the mounting height in order to comply with the 1 meter standard height.

6.4.10. Savukoski rescue station

The verification team verified the AAM station at Savukoski. The detector is located in the parking area of the local fire department; detector electronics and a local display (ALNOR RDS-120) are in the building basement in a small storage room. There is no battery back-up but a diesel generator is available.

Verification does not give rise to recommendations. The verification team points out that the detector location makes it vulnerable to damage from moving vehicles at the parking area.

6.5. STUK REGIONAL LABORATORY IN ROVANIEMI

6.5.1. General

The STUK northern Finland regional laboratory is located in an underground facility in Rovaniemi. The laboratory provides both routine and emergency surveillance functions. The monitoring programme includes monitoring of external radiation, aerosols, fallout, surface water, milk, wild food and occasionally also wild animals. The laboratory is accredited by FINAS according to ISO 17025.

The subarctic nature is sensitive to pollutants and large-scale consumption of reindeer meat (food chain lichen – reindeer – man) makes the area especially important in terms of monitoring ^{137}Cs contamination. This surveillance was started already in the 1960's in order to monitor the fallout of the atmospheric nuclear weapons testing and it was intensified after the Chernobyl accident.

6.5.2. Air sampling

The verification team verified the high volume air sampler Snow White located at a fenced area close to the laboratory. Paper filter (produced by Senya Oy) is changed daily and the charcoal cartridge on monthly basis. The system has two GM tubes underneath the filter for an on-line filter measurement. Data are provided to the USVA database. A system control measurement is performed on three month intervals.

Verification does not give rise to recommendations.

6.5.3. Fallout sampling

Fallout sampling is carried out using a heated sample collector located next to the air sampling system. Sample is collected (rinsing with HNO and water) monthly and analysed in the laboratory.

Verification does not give rise to recommendations.

6.5.4. Analytical laboratory

Verification team carried out a verification of the main analytical functions of the laboratory. The facility is well equipped, but due to the limited size of its underground rooms it has to operate in fairly cramped conditions. The team was informed that since there is no technical reason for maintaining the facility underground, the plan is to move to a normal building in the future.

A demonstration of the SnowWhite filter paper (Whatman GFA) preparations was carried out. The papers are folded and compressed (300 kN) before crushing for placement in a labelled measurement vial. Filter activity is measured using a gamma spectrometry system. For other solid samples the laboratory has two ashing furnaces and one drying cabinet. For water samples there are evaporation systems.

The laboratory has three HPGe detectors (30-40% relative efficiency) with electrical cooling. Detectors have Co-Zn-Pb layer shielding for optimal background reduction. Nitrogen flushing of the measurement chamber is planned, but not yet implemented. The facility is EMP-shielded and has UPS power back-up.

Data are sent to the STUK LINSSI-database in Helsinki. A USB-hard disk drive and tape are used for data back-up.

Calibration of the gamma spectroscopy systems is done using commercial standards. Point source standards are kept in a lead-shielded storage box and the liquid standards in a ventilation cabinet. There is a regular control procedure in place for the gamma spectrum peak width (FWHM) in order to monitor detector stability.

After measurement the filter samples are kept in the counting room; other samples are either discarded (foodstuffs) or stored in the laboratory underground garage. There is no formalised procedure for sample storage and the verification team noted that the available storage space was messy and appeared to be disorganised.

Laboratory has participated in several intercomparison exercises. Staff is partially cross-trained to carry out each-other's functions; in emergency situations additional staff can be sent from Helsinki.

The laboratory has also a mobile monitoring vehicle and a good set of portable instrumentation for field measurements (HPGe and NaI spectrometers, mobile air sampler and several dose rate measurement devices).

The verification team performed a traceability control of an air filter from 12 January 2006 (CR_24_0). All records were found.

> *As a matter of good laboratory practise, the verification team recommends STUK to formalise the arrangements for sample storage and improve the organisation of the sample archives in the Rovaniemi laboratory.*
>
> *As a matter of good laboratory practise the verification team suggests keeping calibration standards in a locked storage.*

6.6. ROVANIEMI CITY FOOD LABORATORY

The normal tasks of the Rovaniemi City Food Laboratory concern microbiology and chemistry. It is one of the regional laboratories, which has been provided with NaI(Tl) detectors for foodstuff radioactivity measurements, in particular for the case of an emergency situation where the STUK laboratories cannot manage the measurement workload any more. The measurement systems in these laboratories are of Russian origin and are managed by STUK. Currently two devices in lead shields are available, one of which is used. Personnel can switch to a second device by changing the corresponding cables. Electronics used is type Radek MKGB-1. The lab has done milk measurements for training purposes. Measurements are currently infrequent (the logbook presented to the verification team shows ca. 2 samples per month on average, mostly Rn in drinking water). The geometry used is a ½ litre Marinelli beaker.

Samples are registered and they receive a number (as the standard routine of the lab). The sample book contains information on who did what and when. Activity results are taken from the PC and then handwritten in the book; a client receives a written certificate whose copy is saved in the PC. Food activity data are also reported to STUK. Data on radon in drinking water are reported only to the customer.

For radioactivity measurements currently two staff members have the according 'license' and two are in training

The verification team was informed that staff checks the system every month with tap water, distilled water or with a test sample supplied by STUK (milk, quartz sand with Cs, Ra, Th, K). Energy checks are performed with a Cs source. Written measurement procedures are available.

Verification does not give rise to recommendations.

7. 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 Finnish territory are adequate. The Commission could verify the operation and efficiency of these facilities.

(2) However, a few recommendations are formulated, mainly in relation to laboratory practise and general quality assurance. These recommendations aim at improving some aspects of the environmental surveillance. These recommendations do not detract from the general conclusion that the Finnish 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 summarised in the ‘Main Findings’ document that is addressed to the Finnish competent authority through the Permanent Representative of Finland to the European Union.

APPENDIX 1

REFERENCES AND DOCUMENTATION

1. Main related websites

- Finnish Radiation and Nuclear Safety Authority http://www.stuk.fi
- Finnish Meteorological Institute http://www.fmi.fi
- Rovaniemi City Food Laboratory http://www.rovaniemi.fi/?deptid=16037

2. Other documents

- Questionnaire on the implementation of Art. 35 of the EURATOM Treaty in the Republic of Finland, 2005.
- Verification activities under the terms of Art. 35 of the Euratom Treaty, preliminary information questionnaire addressed to the national competent authority in view of preparing the Article 35 verification in Finland, 19-23 March 2007.
- Surveillance of environmental radiation in Finland, Annual report 2005, STUK-B-TKO 7, June 2006.
- Radiation Decree (20 December 1991/1512), Finland.
- Decree on Radiation and Nuclear Safety Authority (618/1997), Finland.
- Act on Radiation and Nuclear Safety Authority (22 December 1983/1069), Finland.
- Radiation Act (27 March 1991/592), Finland.
- Finnish Government's Decree on Rescue Operation (787/2003).
- Metivier H., Nielsen S., Tuomisto J., Weiss W., International Evaluation of the Research Activities of the Finnish Radiation and Nuclear Safety Authority, Ministry of Social Affairs and Health, Reports 2006:60.
- Ilus E., The Chernobyl accident and the Baltic Sea, Boreal Environment Research 12: 1-10, Helsinki 22 February 2007.
- Smolander P., Toivonen H., Mobile In-field Measurements in Nuclear or Radiological Threat Situations, Proceedings of the IRPA 11 Conference, 2004.
- Heinonen, J., Keski-Uudenmaan pelastuslaitoksen valmiudet säteilyvaaratilanteessa, Pro Gradu thesis, University of Helsinki, Institute of physics, 2007.

APPENDIX 2

VERIFICATION PROGRAMME

Monday 19/03

1. **09:00 Opening meeting at STUK**

2. **10:00 Verifications at the STUK laboratories**
   Team 1: *Laboratories*
   - laboratory for marine and terrestrial samples at STUK
   - laboratory for foodstuffs samples at STUK

   Team 2: *Equipment and data handling*
   - airborne radioactivity monitoring equipment at the STUK headquarters
   - mobile radiation monitoring equipment at STUK
   - measurement program for monitoring radioactivity in the Baltic Sea

Tuesday 20/03

3. **09:00 Verifications at the STUK and FMI laboratories continue**
   - FMI national environmental monitoring network data centre (FMI)
   - FMI radioactivity laboratory

4. **13:00 Verification of selected measurement stations of the national environmental radiation monitoring network in the Helsinki area**
   Team 1: Monitoring station at Espoo
   Team 2: Monitoring station at Vantaa and the local area alarm centre

Wednesday 21/03

5. **09:00 Verification of environmental monitoring provisions in northern Finland**
   - STUK regional laboratory for environmental and foodstuffs samples

6. **13:00 Verification of selected measurement stations of the national environmental radiation monitoring network in northern Finland**
   Team 1: Rovaniemi City Food Laboratory
   Team 2: Monitoring station at Sodankylä

Thursday 22/03

7. **09:00 Verification of selected measurement stations of the national environmental radiation monitoring network in northern Finland (cont)**
   Team 1: Monitoring stations at Kemijärvi, Salla, Kotala
   Team 2: Monitoring stations at Sodankylä (FMI), Savukoski and Pelkosenniemi

Friday 23/03

8. **13:00 Closing meeting: presentation of preliminary verification findings (STUK headquarters)**