EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

SLOVAK NATIONAL
MONITORING NETWORK
FOR ENVIRONMENTAL RADIOACTIVITY
SLOVAK REPUBLIC

10 to 15 April 2005

Reference: SK-05/3

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FACILITIES:	Monitoring network for environmental radioactivity in the Slovak Republic.
LOCATIONS:	Bratislava, Nitra, Banská Bystrica, Košice
DATE:	10 to 15 April 2005
REFERENCE:	SK-05/3
INSPECTORS:	C. Gitzinger (Head of team)
	P. Vallet ("trainee function")
	A. Godeanu Metz
	F. MacLean(trainee function)
	E. Henrich (detached national expert – Austria)

DATE OF REPORT: 25/04/2006

SIGNATURES:

[signed]

C. Gitzinger

[signed]

P. Vallet

[signed]

E Henrich

[signed]

F. MacLean

[signed]

A. Godeanu Metz

TABLE OF CONTENTS

TECHNICAL REPORT

1. ABBREVIATIONS

Commission	European Commission
EURDEP	European Radiological Data Exchange Platform
DG	Directorate General
FWHM	Full Width at Half Maximum
GM	Geiger-Müller
HPGe	Hyperpure Germanium
IAEA	International Atomic Energy Agency
ISO	International Organization for Standardization
JRC	Joint Research Centre
LIMS	Laboratory Information Management System
MCA	Multichannel Analyser
NIM	Nuclear Instrumentation Module
NPP	Nuclear Power Plant
PC	Personal Computer
PHA	Public Health Authority
QA	Quality Assurance
REM	Radioactivity Environmental Monitoring (European Commission database)
RPHA	Regional Public Health Authority
SHMÚ	Slovenský hydrometeorologický ústav (Slovak Hydrometeorological Institute)
ŠVaPÚ	Štátny veterinárny a potravinový ústav (State Veterinary and Food Institute)
TLD	Thermoluminescence Dosimetry
TREN	Energy and Transport
UPS	Uninterruptible Power Supply
VÚVH	Výskumný ústav vodného hospodárstva (Slovak Water Research Institute)
WMO	World Meteorological Organisation

2. INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State 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 verify their operation and efficiency.

Within the Commission, the Directorate-General for Energy and Transport (DG TREN) and more particularly its Radiation Protection Unit (TREN H4) is responsible for undertaking these verifications.

Normally, the main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of facilities for monitoring:

- 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 TREN visited sites which are part of the national system for monitoring environmental radioactivity. The team was divided into two sub-teams, both dealing with environmental matters at a number of sites (Team1 and Team 2).

The visit also included meetings with representatives of the national and regional Public Health Authorities, the Slovak Hydro-meteorological Institute and the State Veterinary and Food Institute. Details of the programme are given under section 3 below.

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance in the Slovak Republic. The purpose of the review was to provide independent verification of the adequacy of monitoring facilities for:

– Air,

– Soil,

– Waters and

– Foodstuffs.

With due consideration of 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 placed on:

– the on-line ambient dose-rate monitoring system,

– milk sampling and measurement,

– the sampling programme managed by the regional Public Health Authorities, and

– the measurement programme of the central Public Health Authority in Bratislava.

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

The present report is based on information gathered from the documents listed in Appendix 1 and from discussions with the various institutes' staff, listed in section 3 below.

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1. Preamble

The Commission's decision to request the conduct of an Article 35 verification was notified to the Slovak Government on 23 December 2004 (letter referenced TREN/H4/CG/sls D(2004) 21884, addressed to the Permanent Representation of the Slovak Republic to the European Union). The Slovak Government subsequently designated the Public Health Authority (PHA) to lead the technical preparations for this visit.

3.2. Documents

In order to facilitate the preparation of the verification visit, some information was supplied in advance by PHA. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1 to this report. The information thus provided has been extensively used for drawing up the descriptive sections of the report.

3.3. Programme of the visit

The Commission and PHA discussed and agreed upon a programme of verification activities, based on a Draft Communication by the Commission, setting out the framework and modalities within which Art. 35 verifications may be conducted

During the opening meeting the regulatory bodies offered presentations on the following topics:

- Information on the national monitoring system in Slovakia;
- An overview on the status and the expected future developments of the monitoring network in Slovakia.

The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

An overview of the programme of verification activities is provided in Appendix 2.

The verifications were carried out in accordance with the programme. Owing to the wide geographical spread of the institutions of interest and to the complexity of the Slovak national radiation monitoring network the Commission verification team was split in two sub-teams. One team performed verifications on the on-line systems at SHMI Bratislava, SVFI Nitra, RPHA Košice, and PHA Bratislava while the second team verified the off-line systems at SHMI Bratislava, SVFI Nitra, RPHA Banská Bystrica, and PHA Bratislava.

3.4. Representatives of the Slovak competent authorities and the associated laboratories

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

Public Health Authority (PHA) from Bratislava, representing the Ministry of Health:

Dr. Oto Fitz	Deputy Director
Dr. Vladimír Jurina	Head of the Section of Radiation Protection
Mr. Dušan Viktory	Head of the Department of Nuclear Facilities
Mr. Pavol Ragan	Head of the Department of Workplaces with Sources of Ionizing Radiation
Dr. Jan Kollár	gamma spectrometry expert
Dr. Emil Bédi	Senior officer at the Department of Nuclear Facilities

The Slovak Hydro Meteorological Institute (SHMÚ) from Bratislava representing the Ministry of Environment:

Ing. Tereza Melicherova	Responsible for the on-line dose rate monitoring system

State Veterinary and Food Institute from Nitra representing the Ministry of Agriculture:

Mrs. Andrea Vachova	Friesland dairy representative
MV Dr. Ivan Melichárek	Director ŠVaPÚ
Dr. Jan Herceg	ŠVaPÚ, sample taker
Juraj Miššik	ŠVaPÚ, Head of Radiometric and Radio-ecological Laboratory

Regional Public Health Authority (RPHA) from Košice, representing the Ministry of Health:

Dr. Andrea Čipáková	RPHA, Head of the Department of Radiation Protection
Mrs. Balogova	RPHA, laboratory staff
Dr. Viktor Vrábel	RPHA, laboratory staff

Regional Public Health Authority (RPHA) from Banská Bystrica, representing the Ministry of Health:

Pavol Adámek, M. D.	RPHA, Deputy Director, Head of the Department of Radiation Protection
Ing. Ludmila Auxtová	RPHA, Head of the Branch of Environmental Radioactivity
Dr. František Ďurec	Quality Manager, Head of the Branch of Dosimetry and Radiometry
Ing. Alžbeta Ďurecová	Head of the Branch of Radiochemistry

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

4. HISTORICAL BACKGROUND

In 1993 Slovakia separated from former Czechoslovakia (ČSSR) to become the Slovak Republic. On 1 May 2004 it became Member State of the European Union. Environmental monitoring has a long tradition in Slovakia. Monitoring of radioactivity in aerosol and various food stuff samples was first established in the early 60´s during the era of atmospheric bomb tests. Following the Chernobyl accident environmental monitoring was considerably extended and with a few modifications is still performed now. Historically, environmental radiation monitoring and surveillance in the Slovak Republic has concentrated on aerial and liquid effluents from installations, in particular from the Slovak Nuclear Power Plants.

5. LEGAL SITUATION AS REGARDS ENVIRONMENTAL RADIOACTIVITY MONITORING

5.1. Situation at the present time

Although immediately after the separation into the Czech and the Slovak Republics in 1993, most of the former legislation was kept by the successor states, gradually new laws began to replace existing laws and regulations.

Act No. 272/1994 Coll. on the Protection of Public Health forms the legal basis for radiation protection. Subsequent regulations, including Regulation No. 12/2001 Coll. on the Requirements for Radiation Protection issued by the Ministry of Health of the Slovak Republic, define the general requirements for health protection, and for state authorities responsible for health protection, obligations of persons when securing health protection, and requirements for the execution of state regulations and sanctions.

A chapter of this act is dedicated to radiation protection and establishes the basic principles of radiation protection. It specifies requirements for granting permits in respect of activities leading to irradiation, for activities significant from the point of view of radiation protection, and for the management of radiation sources and radioactive wastes. Moreover, it also specifies the responsibilities of license holders; conditions for releasing radioactive materials into the environment; requirements for radiation protection of workers and the public including exposure limits; requirements for radiation protection optimisation; and requirements for radiation protection in case of incident and accident.

According to the Public Health Protection Act, the Regulatory authority consists of:

- the Ministry of Health,
- the Public Health Authority (PHA; Úrad verejného zdravotníctva Slovenskej republiky – ÚVZSR), and
- several Regional Public Health Authorities.

Within the PHA the Section of Radiation Protection is responsible for radiation protection in general. It comprises a Department for Nuclear Installations, a Department of Biological Effects, a Department for Workplaces with Ionizing Sources, and a Department dealing with the Central Register of sources and doses.

The above act and the associated national regulations and governmental orders transpose Council Directive 96/29/Euratom, Council Directive 97/43/Euratom and Council Directive 89/618/Euratom.

In addition, there are regulations on naturally occurring radioactive material (NORM), the Radiation Monitoring Network, the Shipment of Radioactive Substances and IRAW (Institutional RAdioactive Waste, i.e. radioactive waste which does not originate from NPPs), and Radioactive Waste.

5.2. Recent developments

Whereas in the past responsibility for monitoring of environmental radioactivity was distributed between several ministries, the intention is now to concentrate this in a single body. A Governmental Communication (Nr. 674 from 7 July 2004) names the Public Health Authority, which is funded by the Ministry of Health, as being responsible for coordinating monitoring of environmental of radioactivity and for reporting data on environmental radioactivity data to the Commission. At the time of the verification visit, a possible restructuring of the legislation for the national monitoring of environmental radioactivity was being discussed at the political level. Plans exist to make one ministry (Health) responsible for the national surveillance programme as a whole.

6. ENVIRONMENTAL RADIOACTIVITY MONITORING

6.1. Current situation

6.1.1. With regard to nuclear installations

Environmental radioactivity monitoring in the surroundings of the nuclear power plants of Jaslovske Bohunice and Mochovce is carried out by the operators (as approved by the Public Health Authority which is the regulatory authority) and, independently from the operator, by the regulator himself.

Environmental monitoring around the nuclear power station at Jaslovske Bohunice has been performed since the early 1970´s: the area covered extends to 30 km diameter around the plant.

The 21 stations of Mochovce NPP's tele-dosimetric system continuously monitor gamma radiation, aerosol and radioiodine activity in the plant's vicinity. Samples of air, soil, water and foodstuff are regularly measured and evaluated.

6.1.2. General environment

Radioactivity in the environment has been monitored since the end of the 1950's in response to nuclear weapons tests. For example the meteorological institutes were made responsible for monitoring of atmospheric deposition in 1962 when some systems for monitoring of surface water and drinking water were set up. In 1986 the Czechoslovak National Radiation Monitoring Network was established. Its tasks included determination of doses by means of thermoluminiscence dosimetry, measurements of dose rate at more than 50 locations, and analysis of foodstuffs. In 1992 the environmental monitoring and information system was established; until 1999 it was operated by the National Institute of Hygiene and Epidemiology (now the Slovak Public Health Authority). In 2000 a governmental resolution charged the Slovak Hydrometeorological Institute (Slovenský Hydrometeorologický Ústav - SHMÚ) with the administration of this system. The SHMÚ radiation monitoring network is part of the

national radiation monitoring network and it ensures a continuous monitoring of ambient gamma dose rates and of the volume activity of aerosols.
In 2004 the Slovak Public Health Authority was made responsible for co-ordinating measurement of radioactivity in the environment and foodstuffs and reporting the results to the Commission.

Currently, on-line networks monitoring ambient dose rate are operated by Civil Protection (46 devices), by the Slovak Hydrometeorological Institute (25 devices) and by the Slovak Army (11 devices). Measurement locations are given in Appendix 3. Data from the SHMÚ system are collected centrally and are also distributed Europe-wide within the EURDEP system (European Radiological Data Exchange Platform). SHMÚ also runs aerosol samplers in four locations (Hurbanovo, Lučenec, Liesek with measurement at the Regional PHA Banská Bystrica; Stropkov with measurement at the Regional PHA Košice). These samplers are operated on a '2 weeks on/2 weeks off' basis. In addition, an automatic aerosol monitor Bitt AMS-02 was installed in the meteorological station near the Jaslovske Bohunice NPP, in accordance with a bilateral agreement between the Austrian Ministry of Agriculture, Forestry, Environment and Water-Management and the Slovak Ministry of Environment. The measurement data from this continuously operating device are available to both the Slovak and the Austrian authorities.

The Faculty of Mathematics, Physics and Informatics of Comenius University at Bratislava operates a high flow rate aerosol sampler. It also supplies long term measurement series of C-14 and radon in the atmosphere and in waters as well as of gamma emitters in aerosols.

Central and regional PHAs are also involved in monitoring surface water, drinking water, soil, and milk. The State Veterinary and Food Institute (ŠVaPÚ) at Nitra specialises in analysing feedstuffs and foodstuffs (cows' and sheep milk, pork, eggs, honey, game, grain).

Other institutions, such as universities and private organisations, provide measurements on request.

Even though the PHA was charged by Governmental Decree in 2004 with the role of national coordinator for territorial monitoring and reporting to the European Commission, at the time of the visit a certain lack of central coordination was apparent. For example there were considerable delays in reporting the monitoring results required by Article 36 of the Euratom Treaty to the Commission's REM database.

6.2. Recent developments

6.2.1. With regard to nuclear installations

At the present time, no changes are planned to environmental monitoring programmes in the vicinity of nuclear facilities.

6.2.2. General environment

Recent legislation, which entered into force on 1 January 2006, centralised most of the environmental monitoring tasks under the leadership of the PHA, including those tasks performed by other institutes.

Ongoing developments concern both the automatic and the laboratory based system. It is intended to have a single data centre which then communicates on-line dose rates to other users (including EURDEP). The set-up of the laboratory based network will be largely in accordance with European Commission Recommendation 2000/473/Euratom. Mixed diet will

be supplied by local hospital kitchens. With the objective of improvements in quality assurance it is planned to have some of the measurement laboratories accredited according to ISO 17025. The radiochemical laboratory of the RPHU in Banská Bystrica received accreditation according to ISO 17025 in May 2004.

7. VERIFICATION ACTIVITIES

7.1. Bratislava

Representatives of the PHA, the ŠVaPÚ, the SHMÚ and of the Commission team gave presentations containing useful background information.

7.1.1. Slovak Hydrometeorological Institute (SHMÚ) – verification activities and findings

The verification team visited:

The on-line system operated by the SHMÚ at the moment consists of 25 ambient dose rate detectors (Genitron GammaTRACER®; type XL - 'wide'; measuring range 20 nSv/h to 10 Sv/h, calibrated up to 1 Sv/h). 23 of them are installed throughout Slovakia, one is used as a spare and the other one is dedicated for mobile applications. At the time of the verification, half of the detectors were in the process of calibration at the institute, a process that usually takes two weeks. (Calibration of the detectors is performed every two years.) The current calibration accuracy is ± 15 percent whereas the planned new system will achieve ± 5 percent. At most stations the detector is located 1 metre above ground (reference spot between the two GM tubes) with the exception of Hurbanovo where due to historic reasons it is situated on the roof of a building. Generally the connection to the local data acquisition system is by cable although in future it is planned to use Genitron SkyLINK® which is radio based. Onward data transmission to the data centre in Bratislava uses the Integrated Meteorological System in the standard format of the WMO. Precipitation is recorded at the same locations to allow the results of ambient dose rate and rainfall to be linked. However, since precipitation data are collected within the meteorological system, it is only possible to perform this sort of data analysis off-line.

The verification team found the detector mounted in the meteorological garden of the institute to be well positioned with clearly visible detector specification. The tube spots were marked making correct installation easy. The verification team checked the distance soil-middle of the GM tubes and found it to be exactly 1 metre.

The data centre for the on-line radiation monitoring system is located in the main computer room of the institute and enjoys a secured power supply. It consists of two server PCs with backup using dedicated software (MicroStep-MIS®) which are not connected to the meteorological computer. The data collection system also receives measuring results from the military system (consisting of 11 detectors of another type, said to have problems with modernisation). From here, ten-minute values and averaged data are transmitted to the central system which is located in the same room, from where the data are redistributed to Civil Defence (who in addition operate their own network using another type of detector), the Emergency Information System of the Slovak Nuclear Regulatory Authority, EURDEP, Austria, and – in the near future – to Hungary. Dr. Melicherova, the only person who knows

how to manipulate the computer programs involved, tried to give a live presentation but an error prevented a clear demonstration of the system.

The Verification team strongly recommends combining the various on-line dose rate monitoring systems into a single system that allows easier measuring value comparison as well as efficient operation, servicing and data communication to all involved partners.

The Verification team points out that relying on one person for the sophisticated operational tasks may lead to problems in case of extended absence of this person. Thus, the verification team recommends reviewing the allocation of personnel resources.

7.1.2. Public Health Authority Bratislava (PHA) – verification activities and findings

The team visited the premises of the national Public Health Authority in Bratislava (there is also a regional service of the Public Health Authority in Bratislava). The laboratory of the national Public Health Authority in Bratislava is responsible for radiation protection in Bratislava and western Slovakia.

The aerosol sampling station at the Bratislava PHA, although not part of the national monitoring system, is being brought back into service.

Work is ongoing to re-install the gamma monitoring station on the roof of the building, after construction works at a neighbouring building interfered with its line of sight. At the present time this dose rate station does not form part of the national monitoring network.

In addition the national PHA laboratory is also charged under the national monitoring plan with measurement of radioactivity levels in surface water, drinking water, milk and foodstuffs. Surface waters are sampled monthly at a single point on the Danube River. The samples are analysed at the PHA laboratory for Cs-137 and H-3. Drinking water samples are taken monthly from a source in Bratislava and quarterly from a source in Jelka. These samples are analysed at the PHA laboratory for Cs-137, H-3 and Sr-90. These water samples are in addition to the water samples taken in the vicinity of the Bohunice and Mochovce NPPs.

Milk sampling is performed on a quarterly basis. Samples are taken from a single dairy in Bratislava as well as from production from the Bohunice and Mochovce areas. The samples are analysed for Cs-137 and Sr-90 in the PHA laboratory.

Although the national PHA laboratory is part of the national foodstuff monitoring network, the analytical techniques for the analysis were still being developed at the time of the visit. It should also be noted that other than the Bohunice and Mochovce samples, surface water, drinking water, and milk sampling and analysis was only instituted at the beginning of 2005.

The PHA's laboratory is currently being refurbished using surplus equipment from laboratories elsewhere. The PHA has a laboratory manual but does not intend to seek ISO 17025 accreditation until the refurbishment of the laboratory is complete. The verification team observed that the sister laboratory at Banská Bystrica had a well developed QA system in place and that it would be worthwhile to benefit from their experience.

Sampling and Measurement Devices on Roof:

The verification team visited the roof of the main building to examine the aerosol-sampling station and the dose rate measurement station. At the time of the visit the aerosol station was visibly intact and in good condition but had not been used for several years although it was stated that work was ongoing to bring it back into service. No gamma monitoring device was present at the time of the visit.

Sample Preparation Laboratory:

The verification team visited the sample preparation laboratory and followed a tritium analysis and examined calibration procedures in the laboratory.

No system exists for archiving samples.

> *The verification team recommends that the PHA create an archive for retaining samples after analysis for an appropriate period of time.*

The facilities and equipment for preparing water samples for beta analysis were visited and the preparation protocol was discussed. At the time of the visit the measurements were performed using a Tesla Counting System; however a replacement system in the shape of a Thermo FHT 770T Low Level Counter had recently been delivered and was awaiting installation. The sample preparation procedure does not include the periodic checking of blank samples to ensure that there is no cross-contamination between samples.

> *The verification team recommends that the PHA introduce the use of blank samples for quality control purposes.*

The calibration procedures for the H-3 and Cs-137 measurement chains were discussed. Once a year certificated reference solutions are measured.

The team also witnessed a tritium analysis using a Packard TriCarb Liquid Scintillation Counter. The analysis was performed in accordance with ISO 9698 (Water quality -- Determination of tritium activity concentration -- Liquid scintillation counting method). The laboratory has recently purchased a new instrument which was awaiting testing and installation at the time of the visit. Calibration for the TriCarb Counter is done using a certified mother solution.

Measurement results are manipulated and stored in an Excel spreadsheet. The final approved results are recorded in a (paper) logbook. No backup system is in place.

> *The verification team recommends that the PHA invest time in upgrading the system for the treatment of raw analytical data, authorisation of final analytical reports, and back-up of data and results. As the measurements performed at all the PHA laboratories are rather similar the upgraded system could be an organisation-wide system.*

Gamma spectrometry laboratory:

The verification team visited the gamma spectrometry laboratory and interviewed the head of the unit (a nuclear physicist with expertise in gamma spectrometry). An assistant (technician) is available. There are several Germanium detectors in 10 cm lead ring shields available (EG&G© HPGe detector with Ortec© digital signal processing DSPEC© and Ortec GammaVision® Software on PC; Princeton Gamma Tech HPGe detector with a Silena MCA as backup; a Canberra HPGe detector for in-situ measurements). The inside of the lead shields is covered with plastic foil so as to avoid (or to be able to easily remove) any internal contamination.

The lab specialises in gamma spectrometry and receives prepared, labelled samples from other labs, mostly NPP related samples such as soils and sands from western Slovakia. Registration of the samples has recently been introduced (in the past there was no registration) using a PC. The analysis procedure is not documented. A manual for gamma spectrometry containing all documentation and the installation diskettes is available in the measurement room. Gamma analysis is complete (includes FWHM); result printout depends on the type of sample. Monitoring results are manually input in a MS Word® document and sent – in commented form – in batches by e-mail to the Director of the institute.

Corrections (e.g. summing corrections) are not applied for gamma spectrometry because the samples are always very similar and thus corrections are not deemed necessary. If needed, the proper gamma peaks are selected manually.

Energy calibration is checked using peaks such as Cs-137 or K-40 from the sample itself. Even if a small drift is found, a recalibration will be performed using single nuclide point sources or a Eu-152 source. Efficiency calibration is done using self-prepared plastic matrix sources. Calibration is done monthly.

Every two years a sample (liquid in ampoule) is received from the Slovak Institute of Metrology (Slovensky metrologicky ústav). From this a sample in Marinelli geometry is prepared at the PHA and is measured for certification.

Background is measured with a Marinelli beaker containing distilled water. The protective plastic sheet inside the lead shield is replaced every time background is measured.

The Verification team noted that staff is well aware of potential detector deterioration problems and associated signs (e.g. peak broadening).

The lab participates in national and international (Commission, IAEA) intercomparison exercises.

Archiving of spectra is not performed on a routine basis although backup copies are sometimes made on diskette. There is no electronic link between the spectrum PC and the data PC.

No backup power supply is available; thus if power fails, ongoing measurements are lost and have to be repeated.

The lab has no service contract for hardware or software; repairs are managed inside the lab if feasible. Ortec service is available at Bratislava; Canberra service at Banská Bystrica.

The Verification team was informed that accreditation is planned for the future (after renovation of the lab).

The Verification team recommends introducing improved and automated data handling as well as regular spectrum back-up and archiving. It encourages having the laboratories accredited to ISO 17025.

7.2. Nitra

7.2.1. Dairy (Friesland Nitra) – verification activities and findings

The verification team visited the dairy at Nitra which formerly was State owned and now is run by Friesland Slovensko, part of an international food company. The team witnessed the sampling of milk from one of the two 60000 l-stainless steel containers that are in use now. Milk from approximately 300 cows in the west and northwest of Slovakia arrives each night

by truck. At the time of the visit the cows were stabled and fed on hay and silage. Milk is cooled to some 6.5°C and constantly agitated by pumps in the containers. The sampling valve is located near the bottom of the container. After taking the sample and clearing formalities (filling in forms, signatures) the sample is directly transported to the measurement laboratory. Since on the day of the visit meat samples were also to be taken at the slaughterhouse by the same sampling person, the milk sample was marked with a sticker (which is not generally done) and prepared for a chilled transport. Formaldehyde, to avoid coagulation, is used only at the institute.

Verification does not give rise to recommendations. However, it is suggested to ensure that the milk sample containers are always appropriately marked so as to avoid confusion if several samples have to be taken.

7.2.2. State Veterinary and Food Institute (ŠVaPÚ) – verification activities and findings

The State Veterinary and Food Institute was founded shortly after the Chernobyl reactor accident and belongs to the Ministry of Agriculture. Measurements performed by its Radiometric and Radio-ecological Laboratory for various customers range from gamma spectrometry to Sr-90, Ni-63 and Tc-99 determination in various agricultural and forestry food and feed products, soil and water. The laboratory has an ISO 17025 accreditation for gamma spectrometry; it also plans to obtain accreditation for Sr-90 measurements in the near future.

With regard to milk samples, a volume of three litres is lyophilised. The resulting milk powder is placed in a Marinelli beaker for gamma-spectrometric measurement. All milk samples are registered in a laboratory book. In the last twelve months, 52 cows' milk and 11 sheep milk samples were processed. In addition to gamma spectrometry, 100 grams of the milk powder are ashed and undergo beta measurement.

Measurements are made in one of two laboratories depending on the level of radioactivity in the samples. The 'low' level counting room is located in a dome a short distance away from the main building and contains several gamma spectrometry devices (Canberra© and Ortec© hardware; Ortec GammaVision® analysis software) and a Canberra-Packard TriCarb 2250 CA Liquid Scintillation Counter. An alpha spectrometry NIM module (Canberra 7401) was present but had no vacuum pump attached. The 'high' level counting room houses gamma spectrometry systems (Ortec, Nuclear Data©, Canberra, Princeton Gamma Tech© hardware, adapted Nuclear Data analysis software with documentation) as well as a manual and an automatic alpha/beta low level counter (Tesla©).

Calibration of the gamma spectrometry systems is performed using single line sources and a corrected fit (involving density and summing corrections). Formerly, energy checks were done monthly using a Eu-155 source in a Marinelli beaker. Then, the peaks of Cs-137 and K-40 were used if present in the sample and only in case of problems the Eu-155 source or IAEA certified samples (grass, milk powder) were used. Nowadays the K-40 line is taken for this purpose (checking of peak position and peak width). Formerly a checklist with the parameters was kept to follow these observations. Since stability always was good and problems never occurred this procedure was stopped. Slovak authorities ask for regular checks of the system using official radiation sources. Thus, the detectors have a control certificate supplied by the Slovak Institute of Metrology (Slovensky metrologicky ústav) . This is based on the measurement of a sample from this institute by doing five sub-samples in geometries chosen by the laboratory. The laboratory reports back the mean result and – if

accepted – receives a general acceptance certificate, which is not geometry related but pertains to the detector as a whole.

Sample management is based on a sample measurement book that contains all measurements with sample numbers (from the book of sample evidence) noted. In combination with the analysis number, if several analyses are needed, it forms the key number for measurements and the MS SQL©-database.

The procedures covering the operation of the gamma spectrometry system were available for use by the technicians.

All gamma spectra are archived for one year.

The electric power supply system is not backed-up e.g. by a UPS; the old multi-channel analyser (MCA; Nuclear Data) loses all information of the sample measurement at power failure; however, the new MCA (Ortec) keeps the information in memory.

Verification notes that monitoring of detector performance should be resumed as a means of being able to early detect any deterioration of the system and assuring the quality of the system. It is recommended to install a power backup system to avoid time-consuming recovery from losses of measurement information.

7.3. Banská Bystrica

7.3.1. Regional Public Health Authority (RPHA) – verification activities and findings

RPA Banská Bystrica is responsible for environmental radioactivity measurements in central Slovakia. This includes discontinuous measurements of ambient gamma dose rate; measurement of drinking water and river water; and measurement of filters from air samplers operated by the SHMÚ. The laboratory only deals with environmental samples; therefore specially segregated areas to provide protection from cross-contamination are not necessary.

Measurement methods are often inspired by public domain procedures of the United States Department of the Environment.

The institute has made good progress in introducing a Quality Management system. Measurements of gross alpha, gross beta, Rn-222 and Ra-226 of water samples are accredited under the national accreditation system. The institute applies ISO 17025 in the framework of a Quality Manual developed in accordance with ISO 9001. The institute is in the process of obtaining certification for its QA system. The Quality Manual appeared to be comprehensive. Although the verification visit should not be considered as constituting a QA audit, during the course of the visit the opportunity was taken to check that actual activities were in conformity with their description in the Quality Manual; the only discrepancy found was incomplete follow-up of internal audits of the QA system.

The institute participates in inter-comparison exercises organised by the IAEA (Ra-226 in water) and the Slovak Water Research Institute VÚVH.

Samples of drinking water and surface water are measured for gross alpha, gross beta, tritium, Cs-137, Sr-90, Rn-222, uranium, Ra-226, Ra-228.

At the time of the visit, the institute was working on developing analyses of hospital food for Cs-137. The institute intends to install its own system for continuous aerosol monitoring.

The Banská Bystrica RPHA maintains a network of 23 TLDs which are changed quarterly. Whenever a TLDs is changed a 100-second measurement of the ambient dose rate in the vicinity of the TLD is performed using a FieldSpec© instrument. The doses recorded by the TLDs are evaluated at the Banská Bystrica RPHA. The measurements are validated using calibrated TLDs supplied by the Slovak Metrological Institute.

The verification team observed that the TLD at the Banská Bystrica RPHA was located under a conifer tree with the risk of interference with the measurements from radioactivity deposited on the tree.

Samples of surface water are taken once a month from the River Hron nearby, and quarterly from Zvollen and Nezbudská Lúčka. Samples of drinking water are taken once a month from the public water supply in the institute and on a quarterly basis from the reservoir at Turček and the public supply at Žilina.

A justification of the choice for the sampling points, i.e. their representativity, particularly the public water supply at the institute itself, was not given.

The verification team witnessed sample taking at the river Hron: pumping of water from a sampling line in mid-stream into re-usable sampling canisters previously cleaned using HNO_3 and distilled water. There were no particular observations concerning the sampling procedure however it should be noted that sampling of the river Hron only commenced in early 2005.

The verification team also witnessed sampling of the drinking water supply at the institute itself. The sample is taken from the drinking water supply and is drawn into a sampling canister previously cleaned using HNO_3 and distilled water. The samples are gassed to remove radon.

Uranium in water is determined spectro-colorimetrically with old or used equipment (Jenway 6300). The detection limit is 1,0 mg/l and the calibration is done 2 times per year. Procedures and laboratory book (all in one) were available at the workplace.

Tritium analysis on water is done using a Packard TriCarb Liquid Scintillation Counter (model 1000 TQ).

> *With regard to water sampling and measurement the Verification team recommends checking the representativity of the drinking water sampling points.*

The verification team witnessed receipt and preparation of an air filter for measurement. The filters are prepared by another institute and their history, including the intrinsic radioactivity and the conditions of sampling, is not known to the RPHA.

> *The Verification team recommends that air filter-kits be prepared by the institute which will measure the filters or that the measuring institute be provided with sufficient information on the history of filters.*

The verification team witnessed the determination of Rn-222 in water. The technician had detailed knowledge of the analysis procedure and worked according to the quality assurance procedure. The Verification team noted that the operations manual was available at the workplace.

Measurement Laboratories (gamma spectrometry)

The verification team visited the gamma spectrometry laboratory. There are 3 germanium detectors (HPGe) in ring shields (one with lead shield and the two others with copper and lead). Detectors are manufactured by Princeton Gamma Tech (model IGC 30, serial number DI.892). Canberra Genie 2000 spectrum evaluation software is used. Energy is checked using

peaks from Cs-137 or K-40 (662 keV and 1461 keV respectively). Efficiency calibration is done using certified sources provided by the Slovak Authorities.

With regard to data management, there is no electronic database. Final results are stored in an Excel sheet with no back-up. A paper copy of the final results is authorised for release by the laboratory manager. A paper copy of the results is sent to the customer, and one copy is kept at the institute, without a back-up copy.

The Verification team recommends putting a system in place for back-up of raw measurement data and final results in electronic format as well as of final results on paper(e.g. by creation of a Laboratory Information Management System - LIMS). It is recognised that such a system might be very expensive and thus such an effort might best be accomplished nationally.

7.4. Košice

7.4.1. Regional Public Health Authority (RPHA) – verification activities and findings

RPHA Košice is responsible for most environmental radioactivity measurements in eastern Slovakia. This includes dose measurements (by TLD, monthly changes of detectors), soil (at the same locations as TLD; three layers: 0-5, 5-15, 15-30 cm; annual sampling), dose rate (one site on the roof of the Authority building), gross alpha and beta of river water (River Bodrog and River Hornád at Košice) and drinking water (various locations in Slovakia). Drinking water is analysed for gross alpha and beta activity, radon-222, radium-226 and natural uranium. Based on a dose limit of 1 mSv/yr Regulation N12/2001 sets a criterion of 0.1 Bq/l for gross alpha, 0.5 Bq/l for gross beta and 20 Bq/l for radon-222. A written procedure exists for decision on the fitness of drinking water. If the final limit is exceeded the water cannot be used for drinking purposes and the supplier has to be informed; drinking water supply has to be changed to tanks. Also foodstuffs from the Košice district (cows' and sheep milk – stabilised with formaldehyde, fruit, cereals, vegetables, mushrooms, honey) are analysed. A suitable measurement programme has been set up. Generally mixed samples are analysed; in case of exceptional activity values the samples are measured separately. Outside the scope of Art. 35 Euratom, there are large ongoing projects dealing with activity determination in building materials and mineral waters.

There are 52 locations with TLDs distributed throughout Slovakia. The detectors are changed quarterly. All TLDs are sent to the Meteorological Institute in Bratislava for measurement. The verification team visited the location of the monthly TLD dose measurement on the roof of the building (5^{th} floor level). Annual soil samples are taken at surface level in the meadow in the immediate vicinity of the building.

Precipitation is sampled monthly (stainless steel pot, not heated; surface 0.0452 m^2; at sample change the sampler is rinsed using distilled water). During winter, snow is taken separately from the roof surface. Gamma spectrometric measurement and gross beta counting are performed on the evaporated samples.

Dose rate measurements are done on the roof using a Thermo Eberline EPD FHZ detector with natural background subtraction (NBR® method). Data (5-minute-values) are transmitted to a PC two floors below where hourly averages are calculated and stored in an MS EXCEL® worksheet. These measurements have been performed since 1986. This measuring device is not included in the Slovak ambient dose rate monitoring network. The Verification team

noted that the operations manual was available at the workplace (in English; the Slovak version was in another floor). This manual contained information on the system including the data sheet however no description of the PC software.

Air samples (aerosols; sampling is during one week in each month) are taken in the eastern/northern Slovak towns of Stropkov and Liesek by the Hydrometeorological Institute (SHMÚ) and brought to RPHA Košice. There the samples are packed into Marinelli beakers and analysed by gamma spectrometry (in order to determine the activity concentration of Be-7 and Cs-137). Formerly, a test aerosol sampler had been installed on the roof of the RPHA building but the equipment turned out not to operate reliably. Thus, samples and data only for four months were collected. The sampler is now out of order.

Information on the sampling protocol for air filters contains sampling interval (days, but not time!) and the air volume. End of sampling is taken as reference point. (The Verification team notes that this could lead to considerable underestimation for short lived radionuclides.)

> *The Verification team suggests also recording the times of the beginning and the ending of the sampling to allow a better time allocation in particular if more than one sample is taken in a day. The team also suggests reconsidering which time point to take as a reference for decay corrections (e.g. mid-term of sampling or assume constant air flow sampling) so as to avoid significant underestimations of any short-lived radionuclides. Although according to laboratory staff the main aim of this type of measurement is Be-7 and Cs-137, this seems important for cases of unexpected air contamination. The Verification team also suggests signing the sample forms by the person taking the sample to allow an assignment of responsibilities and thus improve quality management.*

Surface water is sampled from Hornád river (monthly) and from Bodrog river (quarterly). Once a year samples from other rivers are taken as well as sediment samples. All these measurement data are shared with Hungary. The Verification team noted that river water samples in approx. 5-l-plastic containers were labelled only with the sample number. Type of sample, sampling date/time, sampling location (or code) were not noted on the containers. In the case of accidentally noting a wrong sample number this could lead to identification errors. Water samples are evaporated (by IR) after gamma spectrometric measurement.

> *The Verification team suggests noting the sample identification on the water sample containers in such a way that a link to sampling date/time and sample location (code) is given with the aim to avoid assignment errors.*

Gamma spectrometry is performed with a 30% relative efficiency Princeton Gamma Tech HPGe detector and a Silena HPGe detector (as backup) in lead brick shields, a Canberra Series 35 Multichannel Analyzer and Canberra NIM electronics. Analysis software is GAMAT (a Czech product running on PC, written by Ian Matzner in 1990; the software manual was at hand; the system offers quite complex analysis options). A mobile Canberra HPGe detector with a Canberra Inspector 2000 gamma spectrometry system is available for in-situ measurements.

Background measurements are done twice per year for the geometries used (0.5-l-Marinelli with distilled water, 0.5-l-Marinelli with sea sand).

Calibration is done using a Europium-152 source.

Every two years certification for gamma spectrometry is achieved by measuring a 0.5-liter Marinelli beaker sample from Slovak Institute of Metrology; this is the standard geometry used at the RPHA (including milk samples which are condensed to this volume). This sample

is also used for quarterly checks of the system. When problems arise, a recalibration has to be done.

Liquid nitrogen for cooling of the HPGe detectors comes from US Steel in Košice.

There is only one person with detailed knowledge of the gamma spectrometry system (although not a technical expert in gamma spectrometry). Other staff are only required to perform sample changes and spectrum storage (on PC using dedicated subdirectories). Spectrum analysis is only done by the above mentioned key person.

A service contract for the electronic equipment has been signed with Canberra in Banská Bystrica. It also covers non-Canberra products. The gamma spectrometry system originally had been set up by Canberra.

The possibility to perform alpha spectrometric measurements is available (a Canberra alpha chamber) but not used. The vacuum pump supplied for alpha analysis which is necessary for keeping a vacuum in the alpha chamber is currently used for applying pressure during operations with liquid nitrogen. Thus, for the time being, the alpha spectrometry system has to be considered as being 'out of order'.

Radon in water is determined by gamma measurement using a NaI(Tl) detector combined with a Tesla single channel analyser taking advantage of gamma rays emitted by radon decay products. The containers are sealed using plasticine.

An automatic alpha/beta low level measuring device (Tesla) is available but not used due to technical problems. Therefore, for alpha/beta measurements at the moment a manual Tesla alpha/beta low level counter with anti-coincidence unit is in operation using pure methane as counting gas. Calibrations are performed whenever the counting gas is changed. High voltage plateau curves are determined using an Am-241 source for alpha and a Sr-90 source for beta measurement. Counting efficiency is determined using self prepared U_{nat} and KCl sources. This system is used for Sr-90 measurements but also for the determination of radium-226 in drinking water (co-precipitation with barium sulphate). After measurement, the counting planchettes are cleaned and reused.

Every day 10 ml of milk are sampled to three liters a month (protected from coagulating with formaldehyde), which then are measured once per month. Strontium in milk is determined using the "Šťavelanová" method (oxalate method; Environmental Measurements Laboratory Procedures Manual, Volchok H.L. and de Planque G.). Every second year the laboratory participates in an intercomparison exercise. The laboratory book for this method contains the calibration curves and all data but no signatures; the description of the procedure was available in the next room. For all computations involved a computer programme (written in BASIC) is available.

Uranium in water is determined spectro-colorimetrically with old or used equipment (recently calibrated). Procedures, a BASIC evaluation programme, and laboratory book were available at the workplace.

Data management for the results from gamma spectrometry and alpha/beta measurements gives the impression of being quite complicated. There are several sample books at the measuring positions which do not contain signatures of any sampling or measuring staff as well as a central sample book giving the sample identifier (consisting of a code and a number). Analysis results are manually written into the central sample book without signature. With regard to gamma spectrometry the only radionuclide of interest (and to be reported) is Cs-137. If other radionuclides are detected the reason has to be found out. Reporting follows a step-by-step procedure. Every three months the values are reported to the

Director; every year a hand written report is produced for the attention of the Director and the PHA in Bratislava. In addition data are stored by manually inputting values in a dedicated dBASE data base and from there to dedicated Excel data sheets.

One office in the RPHA contains the central log book (with all the handwritten measurement results, the protocol books, the results books (for periodical measurements) and copies of certificates. Single printed sheets contain an annual overview of the various sample types per quarter.

There is no backup power supply available at the institute; thus in some cases at power failure measurement information may be lost.

The analysis laboratories are not accredited to ISO 17025.

> *The Verification team recommends having the laboratories accredited to ISO 17025, in particular with regard to gamma spectrometric measurements. This is expected to considerably improve quality management.*
>
> *The Verification team suggests exploring the possibility of using a laboratory information management system that would use unique sample identifiers, include input of sampling and sample information, and that would have connections to the measuring devices and report generators. In particular such a system should be implemented at the next major equipment and organisational overhaul.*
>
> *The Verification team strongly recommends supplying the signatures of the affected staff at each step of the sampling, measurement, analysis and data handling process, so as to keep a continuous track of responsibility.*
>
> *The Verification team points out that relying on one person for gamma spectrometry may lead to problems in case of extended absence of this person. Thus, the verification team recommends reviewing the strategy of allocating personnel resources.*

For sample follow-up an air filter (sample number 133/2005; sampling time 14.-21.2.2005) was chosen. Sample description and results were readily available. However it could not be established from the information provided (a printout) which background file had been used for gamma spectrometry.

8. CONCLUSION

All verification activities that had been planned were completed successfully thanks to the information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities.

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 Slovak territory are in place and are adequate. The Commission services were able to verify the operation and efficacy of these facilities.

(2) However, at the time of the visit, several areas of the national monitoring programme had only been implemented very recently, making it difficult to assess over an extended period of time the quality and effectiveness of the programme in those areas. It will

therefore be necessary, after a suitable lapse of time, to return to Slovakia to verify these areas.

(3) Several recommendations have been formulated, mainly in relation to quality assurance and quality control. These recommendations aim at improving some aspects of the environmental surveillance. In addition, staffing problems have been addressed for some areas. The team strongly encourages the development of legislation which clearly defines the national environmental radioactivity monitoring programme and associated responsibilities. These recommendations do not detract from the general conclusion that the Slovak national monitoring network is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(4) The recommendations are detailed in the 'Main Findings' document that is addressed to the Slovak competent authority through the Permanent Representative of the Slovak Republic to the European Union.

APPENDIX 1

REFERENCES & DOCUMENTATION

Legal sources consulted

1. Legislation

- Act on protection of human health No. 272/1994;
- Regulation of the Health Ministry of SR No. 12/2001 on requirements for radiation protection;
- Act on water No. 184/2002;
- Decree of the government of the Slovak Republic No. 491/2002.

2. Ministry of the Environment

- 'Radiation -Protection Network of the Slovak Hydrometeorological Institute', presentation (slides) by the National Hydrometeorological Institute;
- *'Záverečná ročná spravá čiastkového monitorovacieho systému'* ('Partial monitoring system of environmental radioactivity'), annual report for 2003, Ministry of the Environment.

3. Ministry of Health

- *Obdor Ochrany Zdravia Pred Žiarením, PHA-KE*;
- 'Radioactive discharges in Region of Western Slovakia', presentation (slides) of the Public Health Authority, Bratislava;
- 'Art. 35 SK – national system', presentation (slides) of the Public Health Authority, Bratislava;
- 'Brief introduction in the work of the radiation protection department', presentation (slides) of the regional Public Health Authority, Banská Bystrica;
- '^{137}Cs content in mushrooms from localities in the eastern SK', presentation (slides) of the Regional Public Health Authority, Košice;
- 'Section of health protection against radiation', presentation (slides) of the Public Health Authority, Košice;
- *'Monitorovanie rádioaktivity niektorých minerálnych vôd Košického a Prešovského kraja',* (Monitoring of radioactivity in mineral waters in the Košice and Prešovske districts), presentation (slides) of the Public Health Authority, Košice.

4. Ministry of Agriculture

- 'Dense network for milk sampling', State Veterinary Institute, Nitra, Laboratory of Radiometry and Radioecology;
- 'Sampling and methodology of collection, analysis and control of plants, food and the content of artificial radionuclides', (*Metodický Pokyn ŠVPS SR – 2005)*;
- 'Short information for Art.35 SK – national system', presentation (slides) of the State Veterinary and Food Institute, Nitra;
- 'Methodological instructions of the State Veterinary and Food Administration of the Slovak Republic for the collection and forwarding of samples and analytical control of animal products and feed for artificial radionuclide content for 2005. Radiological monitoring of agricultural raw materials, semi-manufactures and products from the Slovak Republic', number: 9594 /2004-260'.

5. Other sources

- NUKLE-NIKA, Official Journal of the Institute of Nuclear Chemistry and Technology, National Atomic Energy Agency, Polish Nuclear Society: 'Cs content in mushrooms from localities in Eastern SK', by Andreea Čipáková, RPHA Košice;
- '*Systém monitorovania rádioaktivity na území Slovenskej republiky*', presented by Ing. Anna Ondruškova, PHA Bratislava;
- 'Report on activities of the Nuclear Regulatory Authority of Slovak Republic and on safety of nuclear installations in Slovak Republic, in 2003', Nuclear Regulatory Authority of the Slovak Republic;
- Information provided to the European Commission in the framework of the 'Questionnaire on the implementation of Article 35 of the Euratom Treaty, Slovakia';
- Websites:

  Slovak Environmental Agency: http://www.sazp.sk
  The Institute of Preventive and Clinical Medicine: http://www.healthnet.sk
  http://www.enviroportal.sk
  http://www.iszp.sk
  http://www.uvzsr.sk
  Ministry of Health: http://www.health.gov.sk
  Slovak Hydrometeorological Institute: http://www.shmu.sk
  Nuclear Regulatory Authority of the Slovak Republic: http://www.ujd.gov.sk
  NPP monitoring: http://www.seas.sk
  Ministry of the Environment: http://www.enviro.gov.sk

APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY

1. Opening meeting: introduction and presentations
2. Team-1 (on-line systems) starts verification activities (ambient gamma dose-rate and air monitoring) for Bratislava and surrounding region.
3. Team-2 (off-line systems) starts verification activities: sampling provisions put in place by the authorities (foodstuffs, feeding stuffs, environmental media) for Bratislava and surrounding region.
4. Team-1 continues verifying of on-line monitoring system(s).
5. Team-2 continues with verification of sampling provisions and starts verifying the involved measurement laboratories.
6. Team-1 verifies handling of on-line system generated data (local data bases).
7. Team-2 continues with verification of the involved measurement laboratories.
8. Team-1 verifies handling of on-line system generated data (central data base).
9. Team-2 verifies handling of laboratory generated data.
10. Closing meeting at the PHA headquarters with all parties involved.

APPENDIX 3

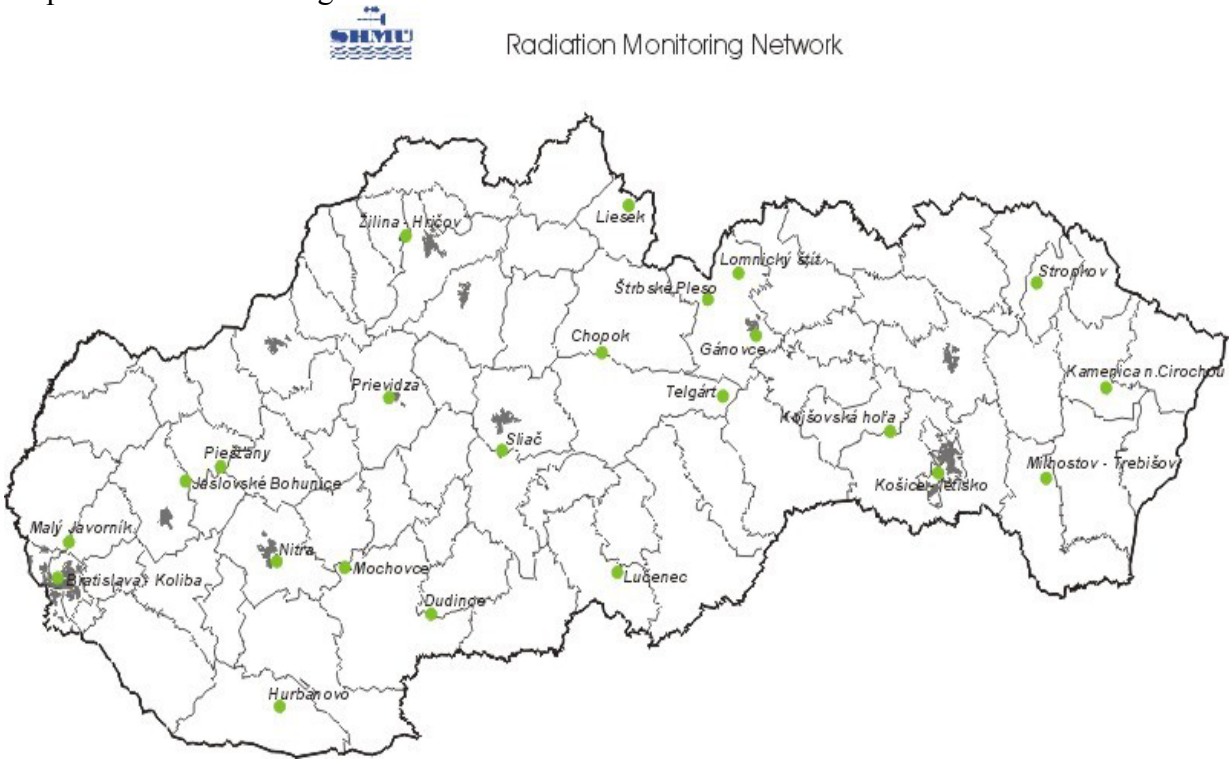
AUTOMATIC DOSE RATE MONITORING NETWORK – OVERVIEW

Radioactivity Monitoring Network of SHMÚ (as of 31. 12. 2002)

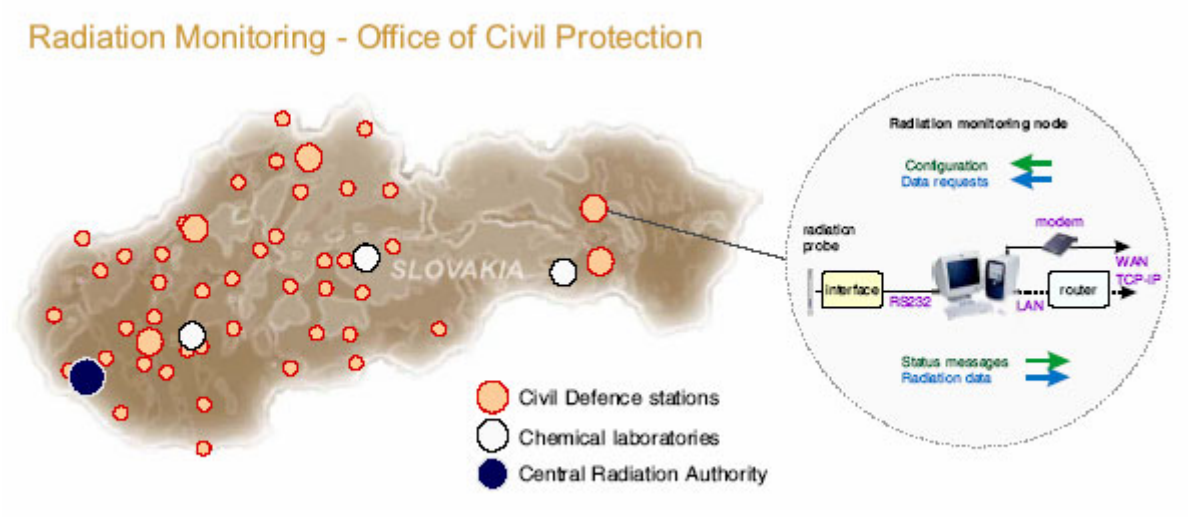
Locations and geographic coordinates of the ambient gamma dose-rate measuring devices are shown in the following table:

N.	Identifier	Station	Long.	Lat.	m a.s.l.
1.	11812	Malý Javorník	48 15	17 09	584
2.	11813	Bratislava-Koliba	48 10	17 06	340
3.	11819	Jaslovské Bohunice	48 29	17 40	176
4.	11826	Piešťany	48 32	17 50	163
5.	11841	Žilina - D. Hričov	49 14	18 37	310
6.	11855	Nitra	48 17	18 08	135
7.	11856	Mochovce	48 17	18 27	261
8.	11858	Hurbanovo	47 52	18 12	115
9.	11867	Prievidza	48 46	18 36	259
10.	11880	Dudince	48 10	18 52	140
11.	11903	Sliač	48 39	19 09	314
12.	11916	Chopok	48 59	19 36	2008
13.	11918	Liesek	49 22	19 41	692
14.	11927	Lučenec	48 20	19 44	214
15.	11930	Lomnický štít	49 12	20 13	2635
16.	11933	Štrbské Pleso	49 07	20 05	1355
17.	11938	Telgárt	48 51	20 11	901
18.	11952	Poprad-Gánovce	49 02	20 19	695
19.	11958	Kojšovská Hoľa	48 47	20 59	1242
20.	11968	Košice-letisko	48 40	21 13	231
21.	11976	Stropkov	49 13	21 39	216
22.	11978	Milhostov-Trebišov	48 40	21 44	105
23.	11993	Kamenica nad Cirochou	48 56	22 00	117

Map of Slovakia showing locations of the SHMÚ Network



Civil Protection System:
Ambient gamma dose rate measuring devices are located at:
Prievidza, Žilina, Lučenec, Trenčín, Ružomberok, Liptovský Mikuláš, Rimavská Sobota, Myjava, Nové Mesto nad Váhom, Ilava, Partizánske, Bánovce nad Bebravou, Púchov, Považská Bystrica, Bytča, Čadca, Kysucké Nové Mesto, Martin, Turčianské Teplice, Žarnovica, Žiar nad Hronom, Banská Štiavnica, Zvolen, Banská Bystrica, Krupina, Detva, Brezno, Veľký Krtíš, Dolný Kubín, Námestovo, Tvrdošín, Poltár, Revúca.



Army System
Ambient gamma dose rate measuring devices are located at:
Bratislava, Sereď, Trenčín, Topoľčany, Ružomberok, Liptovský Mikuláš, Rimavská Sobota, Kežmarok, Prešov, Trebišov, Michalovce.

APPENDIX 4

OVERVIEW OF SAMPLES TAKEN, ANALYSES AND RADIOMETRIC EXAMINATIONS IN 2004 IN THE KOŠICKO AND PREŠOVSKO REGIONS BY THE RPHA KOŠICE

Overview of samples taken, analyses and radiometric examinations in 2004 in Košicko and Prešovsko Regions

Type of material examined	No of chemical and radiochemical analyses								No of radiometric examinations								
	No of samples taken	Total alpha	Total beta	Sr-90	Cs-137	U-nat	Ra-226	**Total analyses**	TLD	Total alpha	Total beta	Sr-90	Cs-137	Rn-222 +RP	Ra-226	Gamma spectroscopy measurements	**Total measurements**
Atmospheric depositions	12	12	12	-	-	-	-	24	-	12	12	-	12	-	-	12	48
Environmental aerosols	14	-	-	-	-	-	-	-	-	-	-	-	14	-	-	14	28
Drinking water, surface water, industrial water, other (control)	594	185	185	-	-	39	39	448	-	185	185	-	3	318	39	3	733
Hydrosphere – bottom sediments and aquatic plants	41	-	-	-	-	-	-	-	-	-	-	-	41	-	41	41	123
Fruit, vegetables	70	-	-	-	-	-	-	-	-	-	-	-	20	-	-	20	40
Cereals	53	-	-	-	-	-	-	-	-	-	-	-	10	-	-	10	20
Sterilised fruit and vegetables	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mushrooms	77	-	-	-	-	-	-	-	-	-	-	-	308	-	-	308	616
Other foodstuffs (milk, honey, salt, malt)	36	-	-	23	-	-	-	23	-	-	-	23	36	-	-	36	95
Air in public facilities and dwellings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued

Type of material examined	No of chemical and radiochemical analyses								No of radiometric examinations								
	No of samples taken	Total alpha	Total beta	Sr-90	Cs-137	U-nat	Ra-226	**Total analyses**	TLD	Total alpha	Total beta	Sr-90	Cs-137	Rn-222 +RP	Ra-226	Gamma spectroscopy measurements	**Total measurements**
Building materials	47	-	-	-	-	-	-	-	-	-	-	-	47	-	47	47	141
Soils	127	-	-	-	-	-	-	-	-	-	-	-	127	-	127	127	381
Crops, compound feedingstuffs	60	-	-	37	-	-	-	37	-	-	-	37	60	-	-	60	157
Swabs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TLD evaluation	92	-	-	-	-	-	-	-	92	-	-	-	-	-	-	-	92
PDE measurements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1115
Total	1223	197	197	60	-	39	39	532	92	197	197	60	678	318	254	678	3589