EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D - Nuclear Energy
**Radiation protection**

# TECHNICAL REPORT

## VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

### JASLOVSKÉ BOHUNICE NPP: DISCHARGE CONTROL AND MONITORING OF ENVIRONMENTAL RADIOACTIVITY IN ITS SURROUNDINGS

### SLOVAK REPUBLIC

**08 to 12 June 2009**

**Reference: SK-09/04**

**VERIFICATIONS UNDER THE TERMS OF ARTICLE 35**
**OF THE EURATOM TREATY**

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| FACILITIES: | Installations for monitoring and controlling radioactive discharges and for surveillance of the environment during normal operations of the Jaslovské Bohunice nuclear power station; facilities of the Slovak national networks for the surveillance of environmental radioactivity. |
| LOCATIONS: | Jaslovské Bohunice NPP, Trnava |
| DATE: | 08 to 12 June 2009 |
| REFERENCE: | SK-09/04 |
| INSPECTORS: | C. Gitzinger (Head of team) |
| | A. Godeanu Metz |
| | E. Henrich |
| | J.L. Frichet (national expert on secondment – France) |

DATE OF REPORT: 17/08/2010

SIGNATURES:

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**TECHNICAL REPORT**

## 1. ABBREVIATIONS

| | |
|---|---|
| *CEPN* | *Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire* (French study centre for the development of protection in the nuclear area) |
| *ČSSR* | *ČeskoSlovenská Socialistická Republika* (former Czechoslovak socialist republic) |
| DG ENER | Directorate-General for Energy (of EC) |
| DG TREN | (former) Directorate-General for Energy and Transport (of EC) |
| *DIN* | *Deutsches Institut für Normung* (German Institute for Standardization) |
| DVD | Digital Versatile Disc |
| *EBO* | *Atómové elektrárne Bohunice* (Bohunice Nuclear Power Plant) |
| EC | European Commission |
| *EKOSUR* | Private company, founded by Ing. Július Plško in 1990 |
| *ENEL S.A.* | *Ente Nazionale per l'Energia Elettrica Società per Azioni* (Italian electric energy provider) |
| ESTE | Emergency Source Term Evaluation code |
| EU | European Union |
| EURATOM | EURopean ATOMic energy community |
| EURDEP | EUropean Radiological Data Exchange Platform |
| ftp | File Transfer Protocol (IT) |
| FWHM | Full Width at Half Maximum |
| GM | Geiger-Müller (radiation measurement) |
| HPGe | HyperPure Germanium (radiation measurement) |
| HWGCR | Heavy Water Gas Cooled Reactor |
| IAEA | International Atomic Energy Agency |
| ICRP | International Commission on Radiological Protection |
| INES | International Nuclear Event Scale |
| IRAW | (Institutional RAdioactive Waste, i.e. radioactive waste which does not originate from NPPs) |
| ISDN | Integrated Services Digital Network (IT) |
| ISO | International Organization for Standardization |
| IT | Information Technology |
| *JAVYS* | *Jadrová A VYraďovacia Spoločnosť* (Nuclear Decommissioning Company) |
| JRC | Joint Research Centre (of the EC) |
| *KTA* | *Kerntechnischer Ausschuss* (German Nuclear Safety Standards Commission) |

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|---|---|
| LAN | Local Area Network (IT) |
| LIMS | Laboratory Information Management System |
| *LRKO-SE* | *Laboratóriu Radiačnej Kontroly Okolia - Slovenské Elektrárne* – (laboratory for radiation control of the environment of SE |
| LSC | Liquid Scintillation Counting (radiation measurement) |
| MDA | Minimum Detectable Activity |
| MH | Ministry of Health |
| $MW_{el}$ | Megawatt (electric) |
| NaI(Tl) | Sodium iodide, thallium activated (radiation measurement) |
| NIM | Nuclear Instrumentation Module |
| NPP | Nuclear Power Plant |
| NRC | (US) Nuclear Regulatory Commission |
| NRPB | (UK) National Radiological Protection Board (now part of the UK Health Protection Agency) |
| PC | Personal Computer |
| PHA | Public Health Authority (*Úrad verejného zdravotníctva Slovenskej republiky, ÚVZSR*) |
| PIPS | Passivated Implanted Planar Silicon (radiation measurement) |
| QA | Quality Assurance |
| RADD | Radioactive Discharge Database (operated by DG ENER) |
| REM | Radioactivity Environmental Monitoring (European Commission database) |
| *RKO* | *Radiačnej Kontroly Okolia* (radiation control of the environment at SE) |
| RPHA | Regional Public Health Authority |
| SE | *Slovenské Elektrárne* (Slovak electric power provider) |
| *SHMÚ* | *Slovenský Hydrometeorologický Ústav* (Slovak Hydrometeorological Institute) |
| *SÚJB* | *Státní Úřad pro Jadernou Bezpečnost* (Czech State Office for Nuclear Safety) |
| *SMÚ* | *Slovenský Metrologický Ústav* (Slovak Metrological Institute) |
| SQL | Structured Query Language (IT) |
| *SÚRMS* | *Slovenské Ústredie Radiačnej Monitorovacej Siete* (Slovak Radiation Monitoring Network Centre) |
| TLD | Thermoluminescence Dosimetry |
| *ÚJD* | *Úrad Jadrového Dozoru* (Nuclear Regulatory Authority of the Slovak Republic) |
| UNSCEAR | United Nations Scientific Committee on the Effects of Atomic Radiation |
| UPS | Uninterruptible Power Supply |
| *ÚVZSR* | *Úrad Verejného Zdravotníctva Slovenskej Republiky* (Slovak Public Health Authority, PHA) |
| WHO | World Health Organisation |
| WWER | Water Water Energy Reactor |
| XML | Extensible Markup Language (IT) |

## 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.

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

The main purpose of verifications performed under Article 35 of the EURATOM Treaty is to provide an independent assessment of the adequacy of 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.H.4 visited the Slovak Republic, in particular the *Jaslovské Bohunice* NPP site and its surroundings and the town of *Trnava*. The team was divided into two sub-teams, one dealing with the monitoring of liquid and gaseous discharges from the *Jaslovské Bohunice* NPP and the other one with the monitoring of environmental radioactivity at the site perimeter and in its surroundings. Parts of the national monitoring network and the measuring laboratories were also included in this verification. Meetings with representatives of the National Public Health Authority (PHA), the Nuclear Decommissioning Company (*JAVYS*) and a private company, performing investigations and evaluations regarding environmental protection in the area of underground water at the *Jaslovské Bohunice* NPP, *EKOSUR*, also took place.

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance at and around the *Jaslovské Bohunice* site. The purpose of the review was to provide independent verification of the adequacy of monitoring facilities for:

- Discharges of radioactivity into the environment.
- Levels of environmental radioactivity at the site perimeter and in the terrestrial and aquatic environment around the site, for all relevant exposure pathways.

With due consideration for 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 operator's monitoring and control facilities for gaseous and liquid discharges of radioactivity into the environment;
- The implementation of the statutory environmental radioactivity monitoring programme as performed by/for the operator and by/for the regulator;
- The sampling provisions and analytical procedures of the *Jaslovské Bohunice* NPP used by the authorised laboratories of the operator:
    - Discharge Control Laboratory
    - Environmental Control Laboratory

[1] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (OJ L-159 of 29/6/1996).

- Several off-site monitoring and sampling stations;
- The off-site radiological environmental monitoring as performed by/on behalf of the regulator;
- The national environmental monitoring programme as established by the competent authority (Public Health Authority) in the region of *Jaslovské Bohunice*.

# 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 by letter on 9 February 2009 (reference TREN/H4/CG/cd D(2009)42688), 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 the PHA. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1 of this report. The information provided has been extensively used for drawing up the descriptive sections of the report.

## 3.3. PROGRAMME OF THE VISIT

The Commission services and the Public Health Authority discussed and agreed upon a programme of verification activities, based on a Communication by the Commission[2], 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:

*Jaslovské Bohunice* NPP, (V2 reactor) gaseous and liquid discharges and environmental monitoring. Special exposés were offered with regard to the A-1 reactor of the NPP, now under decommissioning after accidents in the 70's.

Information on the environmental radioactivity monitoring system in Slovakia, especially in the surroundings of the *Jaslovské Bohunice* NPP. Presentations by the two private companies in charge of decommissioning and environmental protection and impact assessment, *JAVYS* and *EKOSUR*, were also attended. These presentations had a special emphasis on the monitoring and protection of the contaminated groundwater in the vicinity of the NPP, due to the A-1 reactor accident in 1977.

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

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

## 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:

[2] Commission Communication "Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States", Official Journal (2006/C 155/02), 4 July 2006

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| Vladimír Jurina | Head of the Section of Radiation Protection |
| Dušan Viktory | Head of the Department of Nuclear Facilities |
| Ing. Anna Ondrušková | Head of the Department of Laboratories |
| Cecilia Gallová | Radiation protection officer |
| Anna Kepková | Department of Laboratories |
| Emil Bédi | Senior officer at the Department of Nuclear Facilities |

*JAVYS* (*Jadrová A VYraďovacia spoločnosť*, Nuclear Decommissioning Company)

| | |
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| František Šoóš | Radiation Protection Section Director |

*EKOSUR*

| | |
|---|---|
| Július Plško | Director |
| Juraj Benko | Geologist |

*Jaslovské Bohunice* NPP, *EBO* and *JAVYS* divisions

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| Alojz Přidal | EBO, Safety Manager |
| Ľubomír Dobiš | EBO, Radiation Protection division |
| Jaroslav Vražič | EBO, ALARA specialist |
| Ľubomír Doležaj | EBO, Radiation Protection Process Monitoring |
| Ambróz Mužík | EBO, Technical support of radiation |
| Ms Anna Tomášková | EBO, counting and spectrometry laboratories |
| Vladimír Nemčovič | EBO, environmental laboratory |
| Ján Sirota | JAVYS |
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| Mrs. Farkašová | interpreter |
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| Mrs. Bachratá | JAVYS technical support staff |
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The verification team acknowledges the co-operation it received from all individuals mentioned.

# 4. COMPETENT AUTHORITIES & LEGAL BACKGROUND

## 4.1. 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.

## 4.2. COMPETENT SLOVAK AUTHORITIES

Environmental monitoring has a long tradition in Slovakia. Monitoring of radioactivity in aerosol and various food stuff samples was established first in the early 60´s during the era of atmospheric nuclear bomb tests. Following the Chernobyl accident environmental monitoring was considerably extended

and is still performed now with only very few modifications. 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.

### 4.2.1. Ministry of Health

The Ministry of Health (MH) of the Slovak Republic as the highest authority with regard to radiation protection includes the following bodies:

- The Public Health Authority (PHA, *Úrad verejného zdravotníctva Slovenskej republiky – ÚVZSR*) reports to the MH. 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 ionising sources, as well as a department dealing with the Central Register of sources and doses. According to the legal basis, PHA is the Regulatory Authority (regulator) for the Slovak Republic with regard to radiation protection.
- The Regional Radiation Protection Bodies (Regional Public Health Authorities – RPHA) are locally responsible for radiation protection and for the control of radiation protection measures, both on-site and off-site at nuclear installations (Act No. 355/2007 Z.z.). They are also the responsible authorities for supervising radioactive waste from non-nuclear installations until their treatment and transportation for final disposal.
- The Institute for Hygiene and Epidemiology is responsible for providing technical support in the regulation and supervision of radiation protection.

### 4.2.2. Nuclear Regulatory Authority (*ÚJD*)

The *Úrad Jadrového Dozoru (ÚJD,* the Nuclear Regulatory Authority of the Slovak Republic) was established by the Slovak Parliament as an independent governmental body in January 1993 (Act No. 2/1993) as the successor to the former Czechoslovak Atomic Energy Commission.

The Chairman is appointed by the government and co-operates with other central bodies of the state authorities in performing his activities. He regularly submits reports to the Slovak government about the safety of nuclear installations in Slovakia and about his activities.

*ÚJD* was given a mandate to take responsibility for regulating safety of nuclear installations, radioactive waste treatment, safeguards and control of nuclear materials, the whole cycle of nuclear fuel and for quality assurance programmes in the nuclear industry. The execution of this regulation is supported by laws, especially law No. 541/2004.

*ÚJD* has regulatory functions such as:

- establishing standards and regulations;
- issuing licenses for nuclear facilities;
- inspecting facilities and users of nuclear materials.

### 4.2.3. Other regulatory bodies

#### 4.2.3.1. Ministry of the Environment

The Ministry of the Environment is responsible for environmental impact assessments. The Minister for the Environment also chairs the Government Commission for Radiological Emergencies.

#### 4.2.3.2. Ministry of the Interior

The Ministry of the Interior is responsible for fire protection, for support of physical protection of nuclear materials and nuclear installations in emergency situations, civil defence during radiological accidents and for assistance in case of a nuclear accident or radiological emergency [Act No. 42/1994

Z.z. on Civil Protection]. In the event of incidents or accidents, this Ministry must be informed by the operator.

#### 4.2.3.3. State Office for Occupational Safety

The responsibilities of the State Office for Occupational Safety are set out in Act No. 174/1968 Zb. on State supervision of work safety as amended by Act No. 256/1994 Z.z.. The Office is an independent agency which reports directly to the Government on matters of industrial safety.

## 4.3. LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

### 4.3.1. Legislative acts regulating environmental radioactivity monitoring

Although immediately after the separation of the Czech and 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 principal legal basis for radiation protection in the Slovak Republic. Subsequent regulations, including Regulation No. 12/2001 Coll. on the Requirements for Radiation Protection issued by the Ministry of Health, define the general requirements relevant for health protection, and the obligations of the responsible state authorities. They include obligations to be met by persons when securing health protection, and requirements for the execution of state regulations and sanctions.

In addition, Act Nr. 355/2007 Coll. from 21 June 2007 on Protection, Support and Development of Public Health prepared by the Ministry of Health details the legal basis for radiation protection in the Slovak Republic. A chapter of this act is dedicated to radiation protection and establishes its basic principles. It specifies requirements for granting permits for practices significant from the point of view of radiation protection, as well as authorisations for the management of radiation sources, environmental radioactivity monitoring and the disposal of radioactive waste.
Moreover, it also specifies the responsibilities of license holders; conditions for releasing radioactive materials into the environment; requirements for radiation protection of workers and of the public, including exposure limits; requirements for radiation protection optimisation; and requirements for radiation protection in case of an incident or accident.
The Public Health Authority of the Slovak Republic (PHA) was established by this Act.

Act Nr. 355/2007 Coll. 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.

Act Nr. 355/2007 Coll. requires that environmental radioactivity monitoring systems managed by the operator of NPP are established and shall be operational.

Subsequent regulations issued by the Ministry of Health regulations include:

- Governmental decree Nr. 545/2007 from 16 August 2007 (on requirements related to the activities leading to irradiation);
- Governmental decree Nr. 345/2006 from 10 May 2006 (on basic principles and requirements related to the protection of the public and of workers against ionizing radiation);
- Regulation Nr. 524/2007 from 16 August 2007(on the radiation monitoring network).

Environmental radioactivity monitoring in the surroundings of the nuclear power plants of *Jaslovské Bohunice* and *Mochovce* is carried out by the operators (approved by the Public Health Authority i.e. the regulator). An independent control is performed by the regulator himself. The environmental monitoring around the nuclear power station at *Jaslovské Bohunice* has been performed since the early 1970´s. The measuring analytical laboratories of the regulator are:

- The central Public Health Authority laboratory in *Bratislava*;

- The Regional Public Health Authority (RPHA) laboratory at *Banská Bystrica*, responsible for environmental monitoring in central Slovakia (part of the 100 km zone around the *Jaslovské Bohunice* NPP).

There are also regulations on:

- Naturally Occurring Radioactive Material (NORM),
- the Radiation Monitoring Network,
- the Shipment of Radioactive Substances,
- Institutional Radioactive Waste (IRAW), i.e. radioactive waste which does not originate from NPPs, and
- Radioactive Waste.

The Slovak Radiation Monitoring Network Centre (*Slovenské Ústredie Radiačnej Monitorovacej Siete, SÚRMS*) is a permanent executive unit of the Slovak Government's Commission for Radiation Accidents. It is responsible for the methodological preparation of the components of the monitoring network and for standardising its procedures.

Another organisation involved in environmental radioactivity monitoring is the Slovak Hydro-meteorological Institute at *Bratislava* (*Slovenský Hydrometeorologický Ústav, SHMÚ*). It is responsible for the on-line dose rate monitoring system and reports to the Ministry of Environment.

The main activities of *SHMÚ* are:

- to monitor the parameters of the state of air and water in Slovakia;
- to collect, validate, assess, archive and provide data and information for air and water;
- to study and describe atmospheric and hydrospheric phenomena;
- to provide meteorological and hydrological forecasts.

## 4.4. INTERNATIONAL LEGISLATIVE DOCUMENTS

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

- ICRP Publication 60. Recommendations of the International Commission on Radiological Protection 1990.
- IAEA International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. Safety Series Nº 115, 1996.
- Council Directive 96/29/Euratom of 13 May 1996 laying down basic standards for the protection of the health of workers and the general public against the damages arising from ionizing radiation.
- Commission Recommendation of 8 June 2000 on the application of Article 36 of the EURATOM Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the populations as a whole. (2004/473/Euratom).
- Council Regulation (EC) n° 737/90 of 22 March 1990, on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station [Official Journal L 82 of 29.3.1990].
- WHO Codex Alimentarius Commission Guideline 5-1989: Guideline levels for radionuclides in foods following accidental nuclear contamination for use in international trade.

# 5. ENVIRONMENTAL RADIOACTIVITY MONITORING WITH REGARD TO NUCLEAR INSTALLATIONS

Environmental radioactivity monitoring at the *Jaslovské Bohunice* and *Mochovce* NPP sites and in the surroundings of these nuclear power plants is carried out by the NPP operators (approved by the regulator). An independent control is performed by the regulator, PHA.

Environmental monitoring around the nuclear power station at *Jaslovské Bohunice (*30 km diameter) has been performed since the early 1970´s. Currently, the environmental monitoring around the *Jaslovské Bohunice* reactors is done by *RKO*, *JAVYS* and *ENEL*.

With regard to the *Mochovce* NPP 21 stations of a tele-dosimetric system continuously monitor gamma radiation in the plant's vicinity. Aerosol and radioiodine activity are monitored as well. Samples of soil, water and foodstuff are regularly measured and evaluated.

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/bodies.

# 6. *JASLOVSKÉ BOHUNICE* NPP (DESCRIPTION AND VERIFICATION)

## 6.1. JASLOVSKÉ BOHUNICE NPP: OVERVIEW

The *Jaslovské Bohunice* NPP is a complex nuclear site situated several kilometres from the town of *Trnava* and from the *Pieštany spa* centre in the western part of Slovakia, at a distance of about 6 km from the *Jaslovské Bohunice* village.

*Slovenské elektrárne, a.s*. (*SE*), was founded in November 1994 as the successor in title of the company *Slovenský energetický podnik*. Currently *ENEL S.A*. owns 66% of the *SE* shares and the National Property Fund 34%. *SE* is the operator of two nuclear power plants at the *Jaslovské Bohunice* NPP site.

The headquarters of *SE* are located in *Bratislava*.

*SE* comprises the following six organisational units:

- *Bohunice* nuclear power plant (*EBO*);
- *Mochovce* nuclear power plant (*EMO*);
- *Vojany* thermal power plant (*EVO*);
- *Nováky* thermal power plant (*ENO*);
- Hydroelectric power plant (*VE*);
- *Mochovce* units 3 and 4 (*MO34*), NPPs under construction.

Two companies are located "on-site" at *Jaslovské Bohunice*. The company *Slovenské elektrárne, a.s*.- Bohunice nuclear power plant (*SE-EBO)*, which manages the V-2 part (consisting of two units) of the NPP site and the company *JAVYS*.

*JAVYS* is a state-owned company created in 2006 after the privatisation of *Slovenské elektrárne, a.s*.. It is in charge of the V-1 part of the NPP (two WWER units).

The first nuclear power reactor in *Jaslovské Bohunice* was commissioned in 1972. This unit (A-1) had a natural uranium reactor, cooled by carbon dioxide and moderated with heavy water (marked as KS-150). After an accident in 1977 the decommissioning of this reactor was decided. A detailed description is given in Chapter 9.

At the *Jaslovské Bohunice* site electric power was mainly generated in two nuclear power plants, namely V1 and V2. Each of these two power plants consists of two reactor units.

*Nuclear power plant V1 (WWER 440/V230)*

This plant was not subject of the verification visit.

The unit 1 reactor was in operation from 1978 to 31 December 2006, the unit 2 reactor from 1980 to 31 December 2008.

*Nuclear power plant V2 (WWER 440/V213)*

The unit 1 reactor is in operation since 20 August 1984, the unit 2 reactor since 9 August 1985.

Appendix 3 shows a map of the V2 NPP site.

The V-1 and V-2 nuclear power plants consist of pressurised water reactors of the Russian WWER 440 type. The V-1 nuclear power plant primary circuit equipment was supplied by Russian companies, whereas secondary circuit equipment is of Czechoslovak production. During the V1 NPP upgrading period equipment and systems produced in western countries were installed. The majority of the V2 NPP technological equipment was supplied by the Czech company *Škoda Plzeň*.

The standard plant design used in the V2 NPP is WWER-440 model 213. This version was introduced in the late 1970s. Design and other technical aspects of this model have undergone a long period of evolution and have been validated by considerable experience and testing.

At *Jaslovské Bohunice,* the WWER-440/213 NPP was built with modules of two units, in a single reactor building, each unit with six primary coolant loops, isolation valves in each loop, and horizontal steam generators. Two 220 $MW_{el}$ steam turbines supply electric power.

Slovak legislation requires that all facilities that may discharge liquid and airborne effluents into the environment need an administrative license for this.

The license issued for *Slovenské elektrárne* by the Public Health Authority in *Bratislava*, on 2 November 2006 under Nr. OOZPŽ/6272/2006 states the limits for liquid and airborne effluents. The annual limits were based on the projected values of effluents for the power plants provided by the operator.

Pursuant to legal provisions on public heath protection, legal entities are obliged to qualify and quantify harmful factors produced or used during the operation of the respective facility and to ensure that the effect on health is as low as reasonably achievable. Therefore, operators of nuclear facilities are obliged to assure monitoring of radiation parameters at the site of the nuclear facilities and in their surroundings and to evaluate the corresponding public exposure. The operator can carry out these measurements himself or subcontract to authorized organisations.

## 6.2. ON AND OFF-SITE MONITORING BY THE OPERATOR - OVERVIEW

The operator is obliged to submit regular quarterly and annual reports of discharge monitoring (gaseous and liquid) as well as concerning the monitoring of environmental radioactivity (on site and off-site) to the regulator. Moreover, the operator has to report immediately any excess of examination levels, intervention levels or limits.

At the site of *Jaslovské Bohunice*, such monitoring is performed by the nuclear facilities *JAVYS, a.s*. (*Jadrová A VYraďovacia Spoločnosť*, the Nuclear Decommissioning Company) or directly by *Slovenské elektrárne, a.s*..

Off-site monitoring in the surroundings of the nuclear facilities is performed since the 1970ies. Since 2002 it is carried out by the company *Slovenské elektrárne, a.s.* through its laboratories for radiological control of the environment (*LRKO).*

The range of measurements at the site and in the surroundings is specified in a monitoring plan, in which measured components, locations, frequency of measurements, methods of measurements, devices, quality requirements and other details are defined. The monitoring plan is part of the document submitted to the public health authorities by the operator together with an application for an operational licence.

The NPP-operator provides the Public Health Authority with data on liquid and gaseous discharges and the estimated doses resulting from these releases. These data are included in the quarterly and annual operating reports. PHA evaluates these data, verifies compliance with established limits and

conditions, and tracks discharge trends in order to detect operational occurrences and to verify that the effluent treatment systems are operative. Any increases above the normal values lead to investigations. Information is requested from the NPP on the possible activities that could have caused the increased effluent radioactivity levels. Regulatory control of reported discharges is supplemented by the effluent inspections that PHA periodically performs at the NPP. The values measured by the operator and the evaluations generally lead to much lower doses for the population than the dose constraint of 250 μSv/yr for the most exposed persons.

## 6.3. DISCHARGE CONTROL BY THE OPERATOR

### 6.3.1. Gaseous effluents monitoring

All ventilation systems that can potentially contribute to aerial contamination (e.g. containment exhaust system, exhaust system from the reactor hall) have individual aerosol and iodine filters with direct measurement.

Compared to the original design, improvements were implemented for airborne release monitoring. For example, in 1995 a new system ('*THI'* system) was installed. Also the sampling system was changed, following the German *KTA* rules. Air sampling is now isokinetic using 20 representative sampling points (formerly five). In the ventilation stack (at that location the width is 5x3 m) different inlet nozzles according to differences in air speed are installed; all pipes are heated. The team was told that the air speed is very constant; changes only occur at outages (several percent; there is no influence on the isokinetic behaviour).

Within the '*THI'* system the following measuring devices are installed: two for noble gas measurement (*Thermo Scientific FHT 1-59 E*; beta detection, redundant), one continuous for aerosols (*Thermo Scientific FHT 59S-2*), one continuous for radioiodine (*Thermo Scientific FHT 1700*; with NaI(Tl) detector).

The samplers within the '*THI'* system have a 100% redundancy for aerosols (sampling twice a week) and for iodine (weekly) and are of the type *Thermo Scientific FHT 1743*. Additionally, samplers for H-3 and C-14 are installed (bi-weekly sampling).

The verification team was shown the devices used for the '*THI'* system – sampling and measurement. The system is certified and calibrated by the State Metrological Institute. The room with the equipment is located below the stack for the V2 reactors and is locked.

The primary isokinetic sampling line (heated, black Polyurethane insulation) is driven by two *Siemens* blowers; from this line secondary isokinetic lines lead to individual pumps feeding the samplers and the measuring devices.

On the rear side of the equipment racks a vertical pipe leads to the emergency sampling device – for iodine (Marinelli geometry) – located in the level below.

The team noted an *Elster* gas counter for air flow measurement and two independent power lines with UPS (for power spikes) that supply electric power.

A gamma spectrometric measuring device that works in a quasi 'continuous' way is available for noble gas detection (*MVP 2000*). It is installed in a locked box. It contains an electrically cooled HPGe detector (> 20% relative efficiency; *Canberra*; *Genie 2000* software) and has its own UPS for securing electric power; calibration is done by the State Metrological Institute. The team was told that the measurement results can be displayed at each computer in the NPP.

The verification team noted the bubble sampler (sampling of HT+HTO, $C_xH_x$+CO+$CO_2$). The description and the operational procedure with signature were available at the site.

The verification team inquired about action to be taken in case of higher values. It was explained that for the two noble gas devices, if the difference between the two values is larger than 50%, the conservative value has to be taken and the reason for the discrepancy has to be found. If a value is very high (generally valid for all parameters), when there is a warning, the reason has to be checked; when an alarm is given, the reactor has to be shut down. If a value is higher than the foreseen limit the

event is analysed by the plant's 'Protective Action Programme Review Board'. Until now, such an event has never happened.

The team noted also some old instrumentation that is no longer in routine use.

> *The verification team suggests putting easily visible labels on the monitoring equipment showing the 'last date of check' with a view to allow easy control of the validity of checking procedures.*

[Various monitors (at 43 stations) are installed in the NPP galleries for monitoring ventilation air.]

### 6.3.2. Liquid discharge control

The verification team was informed that waters to be discharged stem from operational water treatment stations (via control tanks in building B801), from the laundry, from the changing rooms and from the radiation control and the chemical laboratories (control tanks in building B803). Waters in the B801 control tanks come from evaporators and are mechanically filtered; thus they contain only very little sludge. All these control tanks are sampled before discharge and monthly/quarterly on a routine basis; during discharge the gamma activity is monitored.

In addition, waters in sewerage channels may be discharged. These waters are sampled and analysed daily (gross beta) and with less frequency for tritium and gamma emitter determination.

Appendix 4 gives an overview of the liquid discharge related monitoring programme as defined by *EBO–SE*.

The team was told that compared to the original design liquid release monitoring for operational waters has been changed. Originally four control tanks of 55 $m^3$ each were available in B801 to check before a release, now there is one more with a capacity of 50 $m^3$. These tanks can be selected for filling.

The procedure of sampling tanks requires stirring and sampling of 1 ½ litres (1 l for gross beta, gamma and H-3; 0.5 litres as reserve; the latter serves as a control sample in case of discrepancies between results and also as the control sample for the regulatory authority). The non-processed residues of the basic sample are kept for one month and then returned back to the primary circuit sewage system.

Monitoring during release in the outlet pipeline is currently performed using two *Labeco MR 100* monitors that determine 'gross' gamma activity based on calibration with Cs-137. These devices are located in building B880, near the NPP fence (see chapter 6.3.3 below). Currently, surpassing a set threshold causes an acoustic and visual alarm but does not automatically stop the discharge. The team was told that in such a case the rest of the discharge is stopped manually; a measurement is demanded by the water authority (authority on district level; the regional office belongs to the Ministry of the Environment). The water authorisation is different to the nuclear/radiation protection authorisation; the NPP's own internal requirements are still more stringent. Background averages are determined every three hours. All calibrations are done by the State Metrological Institute. All data (including temperature and flow rate of the discharge) are transmitted to the Main Radiation Control Room. For monthly functional checks using a radioactive source a contract with *JAVYS* is in place. (Such tasks have been contracted also for checks of other equipment). The installation of a new system with enhanced functionality is foreseen. The monitor also diverts discharge water to a specific sampling tank ('quasi-continuous sampling'). Such samples are analysed for gross beta activity, tritium concentration and the determination of isotopic composition.

Discharge samples are taken from the tanks (after stirring) and are analysed in the laboratory. These values are used for balancing the discharges.

> *The verification team encourages installation of a monitor with enhanced functionality.*

### 6.3.3. On-site Discharge related Installations

The verification team visited building B880, located on the site of the NPP, near the fence. It contains the facility for continuous measurement of liquid discharges and quasi-continuous sampling. The team

noted the pipeline below the small building leading to river *Váh*. Two manholes allow access to the discharge canal. Flexible tubes lead to a Venturi meter to measure the flow rate. From there the water is fed into a small basin that serves as source for the sample containers and the two *Labeco MR100* devices. The team was informed that currently only one of them is in operation. The other has a problem with the cabling to the operations room. The display shows gross gamma values in $kBq/m^3$. The measuring chamber has a volume of 16 l and is surrounded by a Pb shield; a NaI(Tl) detector in the centre of the chamber serves for continuous measurement. Every three hours the chamber is emptied and three background measurements are performed (the average value is used for background subtraction calculations).

Sampling is done by feeding water into four plastic sample containers, in intervals of five minutes.

The technical data description was available at site.

Calibration labels (by the State Metrological Institute) were placed on the devices (on the operating one: 8.11.2007; on the other: 13.2.2009; calibrations are performed every two years).

The team noted that the inside of the plastic sample containers is covered with algae.

> *The verification team suggests exploring suitable means to avoid algae growth in the sample containers.*

### 6.3.4. Main radiation control room

With regard to the discharge control operations the verification team visited the main radiation control room, situated in the controlled area of the NPP. It contains the display of discharge related measurements. According to the old Russian design the radiation control room is separated from the operations control room. Two persons generally work in the area, one foreman, one technician.

The shift manager gave a detailed explanation of the set-up.

Originally 400 measuring channels for the two units were available. Later on measurements for N-16 monitors (for steam generator leak detection) and accident monitoring were added.

Data for the flow rate (in the stack and in the sampling line) are also displayed in the control room.

With regard to aerial discharge monitoring the team received a presentation of the '*THI'* system on PC.

With regard to managing liquid releases the team received an explanation of the procedure: The operator asks for a discharge authorisation, subsequently a sample is taken and measured. Based on the result (if the value is less than the given limit) the radiation shift supervisor gives permission for the release. Warning and alarm levels are introduced and lead to various actions if reached.

The verification team was shown the 'Teledosimetry PC'. Access to this network application is from 'all' offices, the laboratory in *Trnava* and by the regulatory body. The system contains data for dose rate on and off site (24 km zone), from 24 measuring stations (boxes; containers): gamma dose rate, continuous aerosol, iodine in discontinuous mode, temperature, etc.

The team was informed that iodine measurements start when another measurement shows high values. The display shows a colour code for the icons, green symbolizing ok, red some error has occurred and blue that some information is missing. Checks are performed by the operations personnel; detailed information is given on the display. The programme was made by staff from the operator's laboratory in *Trnava*.

With regard to meteorological information e.g. for dispersion modelling the operator has a meteorological system with measuring sites at several locations to be able to take into account the influence from buildings and the cooling towers.

The verification team saw that all labelling of the devices is good.

> *Verification activities do not give rise to particular remarks.*

## 6.4. ON-SITE ENVIRONMENTAL SAMPLING AND MONITORING

The verification team was informed that on the NPP site (within the fenced area) areas with surface contamination exist, so called 'supervised areas'. These are regularly monitored.

*Dose rate*

On-site a 'telemetric station', i.e. a system using gamma dose rate monitors, is operated, subdivided into several groups. The devices are mounted on some 3 m high poles. Using collimators the detectors 'see only the cloud'.

In total, 26 such devices are in place on-site: the detectors are connected to the station; the values are transmitted within the NPP network to the operator's laboratory at *Trnava*.

The team was shown devices belonging to the 'fence' system *EBO-5*, the detectors being installed ca. 20 m from the fence. Installing the devices closer to the fence is not permitted for physical protection reasons.

*Ground water*

An important aspect of monitoring is the control of groundwater contamination. On site ten water samplers with automatic sampling, and three specific probes for the different hydrological levels (levels that do not 'communicate' with each other) are installed. As a reason the team was told that H-3 is the main contaminant in the *Jaslovské Bohunice* NPP surroundings (in particular due to the effects of the A-1 accident).

With regard to the A-1 reactor 19 'boreholes' and 52 'test holes' are in place, with regard to the V1 reactors 12 'boreholes' and 10 'test holes'. They serve for sampling and determination of hydrologic parameters. The team verified the presence of several of these sampling and observation locations, e.g. JB2, GB36 and S-6a, as well as the boreholes N8 and N4 that serve experimental purposes.

All groundwater related tasks have been contracted to *EKOSUR*.

Groundwater contaminated by the reactor accident is pumped to the surface and collected in a basin. The water is analysed (tritium determination is performed every day, gamma spectrometry weekly and the determination of Sr-90 and alpha emitters monthly). Depending on the results the water is discharged to the river or undergoes treatment within the NPP liquid discharge system. The verification team saw station '*Vrt 3*' (in container 106) for pumping contaminated groundwater to the surface.

*Monitoring stations*

The verification team visited three automatic stations for monitoring aerosol radioactivity (total beta), radioiodine in air and dose rate. Air flow rate of the device is 180 $m^3$/h.

Filters are changed every two weeks. The measuring cycle for the beta measurement (the detector being located in the filter box above the filter) is 5 min.

For iodine measurement a *Canberra* system with NaI(Tl) detector is used.

The communication for the automatic air monitors to *LRKO* at *Trnava* (distance some 15 km) is made by a radio link.

Similar devices are operated at the *LRKO* laboratory in *Trnava* (see chapter 6.6.2.).

*Soil and grass*

Soil and grass samples are taken at three locations, near the reactors A-1, V1 and V2, once a year.

At each location, firstly grass is collected on three spots, then at these spots soil is sampled to a depth of 5 cm, using a special shovel with a surface of 200 $cm^2$. The samples from the three spots are pooled for analysis.

*Precipitation*

The verification team saw the precipitation sampling device (80x80 cm surface), located beside the container of one of the monitoring stations outside the NPP fence. The station is protected by a separate fence with a locked gate. The water is collected monthly for gamma, alpha, Pu-239 and Sr-90 analysis.

*Meteorological station*

The verification team also saw the meteorological station where parameters such as precipitation etc. are determined. Wind data are not registered at this central location (they are collected at several other spots between the buildings), since the effect of the various buildings makes a more sophisticated modelling approach necessary.

*Verification activities do not give rise to particular remarks.*

## 6.5. OFF-SITE ENVIRONMENTAL SAMPLING PROGRAMME (OPERATOR)

The primary purpose of the environmental monitoring programme performed by the operator of the NPP is to estimate the total radiation dose received by a member of the public in the surroundings of the NPP. Samples for this programme are regularly taken in the environment and from the food chain. In this context the term 'sampling' includes the collection of samples in the environment for laboratory analysis and also selective measurements of dose using TLD devices in the environment to assess external exposure pathways. The gamma dose rate monitoring network is installed with a view to quickly supply relevant data in emergency situations.

*Aerosol*

Besides the NPP site itself, aerosol samplers are installed at *Jaslovce*, *Bohunice*, *Radošovce*, *Kátlovce*, *Nižná*, *Veľké Kostolany*, *Pečeňady*, *Žlkovce*, *Malženice*, *Trakovice*, *Krakovany*, *Piešťany*, *Šulekovo* and *Trnava*. Collection is on filters with a size of 65 cm x 57 cm. Air flow rate is some 180 $m^3$/h, sample change is weekly. Measurement is by gamma spectrometry. For some stations Sr-90 and Pu-239/240 is analysed on monthly composite samples.

*Dose rate and dose*

Besides locations on the NPP site there are points for dose rate measurement (using a pressurized ionisation chamber and in situ gamma spectrometry; the devices being installed 1 m above ground) at *Jaslovské Bohunice, Radošovce, Kátlovce, Nižná, Veľké Kostolany, Pečeňady, Žlkovce, Malženice, Krakovany, Piešťany, Hlohovec, Šulekovo* and *Trnava*. Measurements are performed twice a year with dose rate as final result.

TL dosimeters (type $CaSO_4$(Dy)) are exposed at (in total) 24 locations, i.e. besides at the NPP site at *Jaslovce, Bohunice, Radošovce, Kátlovce, Nižná, Veľké Kostolany, Pečeňady, Žlkovce, Malženice, Trakovice, Krakovany, Piešťany, Šulekovo* and *Trnava*. Exposure times are the calendar months.

*Fallout*

Besides the NPP site, sampling locations for fallout are set up at *Bohunice, Nižná, Veľké Kostolany, Pečeňady*, and *Trnava*. Sampler surface is 0.81 $m^2$. Collection is monthly. All samples are analysed by gamma spectrometry, some also for Sr-90 and Pu-239/240.

*Soil*

Besides the NPP site, soil sampling locations for grass surfaces are at *Pečeňady, Žlkovce, Piešťany, Šulekovo* and *Trnava*, and for arable lands at *Bohunice, Radošovce, Kátlovce, Nižná, Veľké Kostolany, Trakovice and Krakovany*. Grasslands are sampled once a year in autumn, arable lands once a year in spring. A shovel of ca. 200 $cm^2$ is used for sampling; sampling depths are 0 to 2 cm and 2 to 5 cm for arable lands and 0 to 5 cm for grass surfaces. Samples are dried, cleaned of plant residue and stones and homogenized. All samples are analysed by gamma spectrometry, some also for Sr-90 and Pu-239/240.

*Grass*

Besides the NPP site, grass is sampled twice a year at *Jaslovské Bohunice, Radošovce, Kátlovce, Nižná, Veľké Kostolany, Pečeňady, Žlkovce, Malženice, Hlohovec, Krakovany, Piešťany* and *Trnava*. Sample mass is about 5 to 10 kg. Samples are dried and homogenized. All samples are analysed by gamma spectrometry, some also for Sr-90 and Pu-239/240.

*Food: Milk and agricultural products*

Milk is sampled weekly at dairy farms in *Nižná, Pečeňady, Dolné Dubové and Drahovce*. Gamma spectrometry is performed on monthly, Sr-90 determination on quarterly composite samples.

For agricultural products sampling points are not precisely defined; they depend on agro-technical conditions. However, a minimum of 32 samples is taken covering in particular barley and wheat but also corn, sugar beet, oil seed rape, sunflower and potatoes. In addition, other foodstuffs such as pea, fruit and vegetables are occasionally sampled. Sampling is at the end of the vegetation period, immediately before harvesting, sample mass is about 3 to 5 kg. For analysis the consumable parts are taken. All samples are analysed by gamma spectrometry, the most frequent kinds also for Sr-90 and Pu-239/240.

*Surface water, sediment, aquatic plants*

Surface water sampling points are the river *Dudváh* at *Veľké Kostolany* and *Bučany*, the *Žlkovce* Canal, and the river *Váh* at *Madunice, Varov Šúr* and *Horné Zelenice*. Sampling is done once per month, using a pump or a bucket, sample volume is 60 l. On all samples gamma spectrometry, gross beta, gross alpha and tritium measurements are performed, some samples are also analysed for Sr-90 and Pu-239/240.

For bottom sediments the sampling points are at the *Manivier* Canal, the river *Dudváh* at *Veľké Kostolany* and *Bučany*, and at the *Králová* water reservoir. Once a year samples of ca. 5 kg are taken by a suitable tool, down to a depth of 5 cm. Samples are dried at 105°C and milled. Samples are analysed by gamma spectrometry and also for Sr-90 and Pu-239/240.

*Drinking water*

Monitoring aims at checking any contamination in the first horizon of underground waters. Sampling points are drilled holes at *Kátlovce, Veľké Kostolany, Žlkovce, Malženice, Trakovice, Zelenice, Siladice* and *Malženice* as well as a well in *Jaslovské Bohunice* and the *Hlohovec* water supply system. Sampling is once a quarter, the amount is 10 l. All samples are measured for gross beta and tritium content, the samples from *Hlohovec* also with regard to Sr-90.

*Verification with regard to the programme does not give rise to particular remarks.*

## 6.6. THE OPERATOR'S LABORATORIES

### 6.6.1. Laboratory for discharge samples

The operator's 'spectrometric laboratory A0123' (which consists of a group of individual labs and besides discharge sample measurements also carries out special measurements) is located on site. It provides services for *SE-EBO* and for *JAVYS*.

Generally it performs the following measurements:

- Gross beta measurements for samples with activity in the range of 0.02 to 1000 Bq (uncertainty range 10 to 30%, measuring time 3600 sec);
- Tritium measurement in liquid samples (activity some 6 Bq/l, measurement uncertainty 10%, measuring time between 9 and 270 minutes);
- Gamma spectrometric analysis of various kinds of samples (generally the measurement uncertainty is between 5 and 30%).

Analysis of C-14 is performed at the operator's laboratory in *Trnava* (see chapter 6.6.2.), determinations of radiostrontium and transuranium isotopes have been contracted to the Department of Nuclear Chemistry at the Faculty of Natural Science of the Comenius University in *Bratislava*.

The verification team was told that usually four persons are working in the lab, at the time of the visit one of them was on training.

The laboratory does the analysis of the *SE-EBO* samples (i.e. with regard to the V2 reactor units and *JAVYS*) on a contract basis; also samples of other origins are handled; the number of samples per year is 2000 (for V2) and 5000 (*JAVYS*, V1, others). The analytical techniques for liquid and gaseous release samples cover gross beta measurements, gamma spectrometry, and the determination of tritium and fission products. Determinations of C-14, Sr and transuranium elements are delegated to the operator's environmental laboratory at *Trnava* respectively to an accredited laboratory at the *Bratislava* Comenius University.

*Sample management*

Most of the sample preparation is done in the laboratory, some samples come from other departments (chemistry, radiation control).

With regard to sample (and data management) the steps are: sampling – registration - sample preparation – measurement – protocol – data base – balancing – reporting.

The team visited the sample preparation room and noted that all sample bottles were well marked (sample type in coded form; date, for some samples also time of sampling; name of sampler, for some samples also phone number of sampler).

The team observed preparation of liquid discharge samples for gross beta measurements in a chemical hood. After acidification (citric acid) in a first step the sample volume (originally 100 ml) is reduced on a *CERAM* cooking table; then the sample is manually transferred to a measuring planchette on which evaporation to dryness is performed.

The team noted that some of the planchettes used for example for gross beta measurements were not marked thus leading to a risk of sample mix-up.

For H-3 determination samples are distilled, *Instagel Plus* (*Packard*) is used as scintillation cocktail.

Monthly discharge tank samples of 800 ml are taken (300 ml for Sr and transuranium analysis, the rest for gamma spectrometry). For gamma spectrometry the sample is prepared by acidification with HCl and by evaporation to dryness.

All sample information is entered into the *'ARSOZ'* system, a system that allows handling various tasks in the NPP; a short description is given in the sector 'Quality Management' below. The system includes LIMS functionality, thus sample registration is in the *'ARSOZ'* system.

*Beta measurements*

For gross beta measurements a *Thermo Eberline ESM FHT770T* device with six measuring places is available. The team noted the calibration label on the device (Metrological Institute, 11.10.2007).

For tritium determinations a *Packard TriCarb 2700 TR* LSC device is currently used. A new *Perkin Elmer TriCarb 3180 TR/SL* liquid scintillation counter is still in test; it has not yet been calibrated by the Metrological Institute.

Calibration sources for H-3 are traceable to the Czech Metrological Institute (*ČMI-IIZ)*. For gross beta measurements sources *Eurostandard EM145* and *EM145X* supplied by the Slovak Metrological Institute (*SMÚ*) are used with Sr-90 as reference activity.

*Gamma measurements*

The laboratory operates four gamma spectroscopy lines with five detectors. Three detectors are mounted in standard lead shields (two are manufactured by *Tema Sinergie*, Italy, one is from *Nuclear*

*Data*). One line consists of two detectors that are mounted one above the other (end cap above end cap); the collected spectra are summed for analysis. The system is set up in a special shield produced by *All Deco s.r.o.*, Slovakia, consisting of 10 cm Pb and 2 mm Cu. The shield allows moving the upper detector to a higher position to be able to introduce the samples.

The laboratory uses plastic foils for protection of the detector end caps with a view to avoid contamination.

All detectors are from *Canberra*, their relative efficiencies lying between 20 and 60%, the resolutions between 1.7 and 1.9 keV. All data sheets were available at the working place. One system is digital, the others are analogue; NIM units are from *Canberra*.

For spectrum acquisition and analysis *Canberra Genie 2000* is used.

Calibrated geometries are: air filter, 500 ml and 1 l Marinelli beakers; *Canberra ISOCS* is also used. For the air filter geometry the standard was produced by *ČMI-IIZ* (mixed radionuclide source with Zn-65, Cs-137, Am-241). For liquid samples (Marinelli geometries) a liquid standard from *SMÚ* is used to make own calibration sources. Calibrations are done for each new detector or after detector repairs.

Energy checks are performed every week using a Co-60 source; efficiency checks are done every 2 years. Background spectra are collected every month. The laboratory uses the built-in *Canberra* QA programme to follow trends in system performance.

Summing corrections are applied only for the *Canberra ISOCS* system; the other geometries are experimentally calibrated without summing correction.

Density corrections are not applied because sample types do not change.

Liquid nitrogen for detector cooling is supplied every 2 weeks from chemical industry near Nitra.

Maintenance of equipment is guaranteed by service contracts. The electric power supply is secured by UPSs for 'everything'.

*Quality management*

The laboratory is not accredited to ISO 17025. However, according to the Slovak Metrological Act all measurement devices have 'certification' by the metrological institute. Calibration labels with the date of calibration are placed on all relevant equipment. The laboratory has a dossier with all calibration certificates (validity is two years).

The team was informed that the laboratory participates in inter-comparison tests e.g. organized by IAEA (last: coal fly ash); the results were ok except for Am-241. Also the environmental laboratory, the TLD measurement team and emergency related tasks regularly are subject to inter-comparisons. Formerly, the environmental lab participated every year in inter-comparisons at national level; this has been stopped because due to organisational changes it is now 'merged' with the discharge lab.

For 2009 the participation in the IAEA project 'ALMERA' (Analytical Laboratories for the Measurement of Environmental Radioactivity) is foreseen.

The verification team was shown all procedures and a document showing the responsibilities within the laboratory .

For all tasks the (universal) computerized calculation programme '*ARSOZ*' is used, a system that was originally developed by *VÚJE a.s.* (a firm specialized in the nuclear area, located at *Trnava*), in close connection with the users. A new programme based on *SAP* ('*Systems, Applications, and Products for data processing*' of *SAP AG*) is under preparation, which will cover all aspects of the NPP operation including work management; however, data migration problems still have to be solved. For legal dosimetry migration seems not to be possible: a separate system had to be set up.

*'ARSOZ'* is an automatic system for asset management containing a data base for all equipment in the NPP; access is via the NPP network.

The team received a demonstration of *'ARSOZ'*. The system consists of four parts: equipment management (including failure messages, planning etc.); operation; administration (includes personnel, visitors, medical); and radiation protection ('dosimetry'). The latter has 11 modules and includes transport protocols; personal dosimetry; and laboratory measurements with sample description (an internal number serves as a unique identification number), demanded analyses, manually or automatically generated results, validation by different persons, etc.. Due to security reasons no direct interfaces are installed between the measuring devices and the system. Protocol printouts (e.g. an 'ok' for a discharge) are sent to the shift foreman within the system. Archiving for the whole *'ARSOZ'* system is done by the IT group.

Access to information is organized in such a way that 'all' can read the archive, however write access is limited depending on the individual access level.

Measurement results from external sites (e.g. Comenius University) are manually typed in. These data include also the local (i.e. measurement laboratory internal) 'evidence number' to allow an efficient control.

The *'ARSOZ'* procedure (describing all functions) was available at the work place.

The presentation of the *'ARSOZ'* capabilities included the data export and calculation facility; the oldest data contained are from 2005. Data from before are stored in a precursor programme based on *FoxPro*, developed by *Trnava* laboratory staff.

The team was informed that *'ARSOZ'* also supplies output for a dose calculation module (for routine discharges), *ESTE AI* (*ESTE* annual impact), Version 2.3.1.

This module is also able to calculate radionuclide releases as short puffs, e.g. of I-131. It uses local meteorological data, data on local agricultural land use (based on satellite photos) and data on local consumption habits etc. for dose estimates. The programme was developed by *AB Merit*, *Trnava*; the contract with this company covers annual updates e.g. with regard to growth and demographic information. The programme is also used by the Czech NPPs *Temelín* and *Dukovany* as well as by the Czech nuclear regulator *SÚJB* and the Austrian federal radiation protection authority. For the programme Slovak and English versions are available. It can calculate exposures also for Austria, the Czech Republic (with less data). For up to 100 km distance calculation is in sectors, for more than 100 km it is in a more global way. The programme was validated with NRPB's '*PC COSYMA'*, NRC's *'Dose'* and other models.

With regard to accident dose estimates the NPP currently uses the Real Time Accident Consequences (RTAC) model. The team was informed that the newly developed *ESTE EBO* V2 model is not yet used because the necessary link is not yet available.

*Reporting*

Besides periodic (monthly, quarterly and annual) reports specific reports e.g. for outages are produced.

Quarterly reports are sent to the regulator, to the radiation protection and the nuclear safety authority, to *VÚJE*, *JAVYS* and 'partners' in the Czech Republic. Annual reports go to the regulatory body, to IAEA's *'DIRATA'* database, to *CEPN* in France on a voluntary basis, to the European Commission (RADD) and to UNSCEAR (indirectly, every 5 years).

The verification team was told that formerly for reporting of values lower than the minimal detectable activity (MDA) the MDA value was taken as 'activity' value for the sample; from 2008 on in such a case 50% of the MDA value are taken as activity value for the sample, which lead to a virtual 'reduction' of reported discharge values.

*Archive*

An electronic archive exists within the *'ARSOZ'* system; for redundancy a printed version is kept in the laboratory for five years according to an IAEA recommendation, ten years for release result reports. Since 1997 all gamma spectra are archived on DVD; for this no obligation exists.

A sample archive exists for stack releases (three years for sample number '1'; sample number '2' is available for outside laboratories). Samples coming from other units after analysis are returned to the unit providing the sample.

*Tracing*

The team performed a tracing of the results of the aerial discharge sample from April 2006. Basis was the repetition of the evaluation of the gamma spectrum. The measurement value for Ag-110m was followed until the reporting to the European Commission (RADD discharge data base). All steps could be performed within the *'ARSOZ'* system in a quick and efficient way. They showed a perfect match.

> *To avoid possible mix-up of samples prepared e.g. for gross beta measurement the verification team suggests marking all planchettes (e.g. by using planchette numbers, scratched into the bottom or at the side, that can be used as key information) allowing easy sample identification.*

### 6.6.2. Laboratory for environmental samples (*Trnava*)

The verification team visited the operator's laboratory at *Trnava* (*Laboratóriu Radiačnej Kontroly Okolia – LRKO*; environment laboratory), where (primarily) environmental samples are analysed.

Eight persons work in the laboratory, in groups; the tasks range from collection of samples, (radiochemical) sample preparation and measurement to dosimetric evaluation. The team was told that the tasks of the radiochemistry group (three persons) cover monitoring of radioactivity plus managing the telemetric system and emergency response tasks.

Generally, the laboratory's tasks cover a radius of 25 km around the NPP. The laboratory measures about 1300 – 1500 samples per year.

The verification team had the impression that the level of IT knowledge in the laboratory was very high. For some areas commercial computer programmes are used, however supporting programmes are created in the lab.

All radioactive sources are kept in a separate room in the radiochemistry laboratory, in a cupboard.

To secure electric power the laboratory has several UPSs and a diesel generator.

*Sample management*

The laboratory has a time schedule (compiled in *Excel*) for the whole year establishing what sample has to be taken and when (e.g. every week milk, every two weeks stack C-14). This allows an easy overview of the work load. A flow chart shows the sample treatment in the laboratory, this includes actions in case of extraordinary events.

Milk samples are taken once per week. From these, monthly compound samples are measured by gamma spectrometry; quarterly compound samples are analysed for Pu-239 and Sr-90.

The team was shown the soil sampling device (200 $cm^2$ fixed area, suitable for 0-2 and 2-5 cm depths), the sediment and surface water sampling devices (for grab sampling) and the pump and tubing for groundwater sampling.

After sampling and the transport to the laboratory samples are registered with all relevant data in the *'ARSOZ'* system. A document accompanying the sample is printed.

Several rooms are available for sample preparation. The team noted several *Binder* dryers , a *LAC* incinerator which is used for preparation for total beta measurements, calibrated balances type *RADWAG XA220*, *RADWAG WPS4000 C/2*, *RADWAG WPS2100 C/2* and *Chyo JL-200* (all with calibration labels), and liquid sample evaporation boxes with infrared heaters.

One room is dedicated to radiochemical preparations for Sr-90 and transuranium element analysis, containing among other a new *Milestone Ethos 1* advanced microwave digestion system and a *Thermo Electron Jouan B41* multifunction centrifuge, a *Binder* dryer and two *GFL 3017* sample shakers.

The laboratory has a *Lyolab G LSL Secfroid* freeze dryer for (milk) sample lyophilisation. The team was told that currently the device has problems and a replacement was needed.

*Teledosimetry system*

The laboratory is responsible for the operation and data handling of a system that covers on-line measurements of various parameters with a view to supply dosimetric information. Three ranges are defined, one being the radius of 3-6 km from the NPP. Every five minutes 24 monitoring stations transmit data to the lab.

The system includes detectors near the NPP fence (gamma dose rate; iodine, beta activity of aerosols).

Every three seconds stack and relevant reactor data are transmitted.

A meteorological station with four measuring points situated in the 3-6 km radius from the NPP provides relevant meteorological information to the system. All calculation results are presented in a *MS Word* document (dose calculation, critical group and emergency situation information). The data are archived and stored on the system's server and also saved in a computer in the operation's room located in the laboratory's premises. The data are also directly linked to the NPP's 'crisis room' and to the Slovak competent authority for nuclear safety. Data are communicated to the *'ARSOZ'* server via LAN and a radio communication network.

A colour code for the icons used for the identification of the data item allows a quick rough evaluation of the situation and/or the status:

- *Yellow* (warning level) shows that some defined levels have been (slightly) exceeded.
- *Red* is the second level of warning indicating that a certain level has been exceeded. A supervision of the system has to be done by NPP staff (e.g. to check if it is a real alarm or a problem with the detector). For such occasions a special procedure is in place.
- *Blue* indicates that the measurement value of the detector is zero (e.g. due to a defect of the device).

The verification team visited the dosimetric control room where data servers, PCs for data presentation and data transfer and the PC for the teledosimetry system as well as a radio station for emergencies (communication with vehicles) are located. It received an extensive explanation of the functionality of the teledosimetry system, e.g. with regard to the control of the radio communication network (the status of the stations, the quality of the signal, etc).

At the time of the visit the icon representing aerosol activity showed a high level. The verification team was informed that this was a system mistake due to a software error; correction was ongoing.

*Alpha and beta measurements*

Total beta measurements are done using an old *FAG Multi Low Level Counter FHT770T* (six positions) with PC and *Thermo Eberline ESM* software. A new *Canberra Mini 20 Alpha Beta Multi Detector* is also available. Every day short background tests are done. The team was informed that there are still problems with the accuracy of the device. Argon Methane as counting gas for the devices is supplied by *Linde*.

An old *TESLA* automatic alpha beta counting system is not in use anymore.

For liquid scintillation counting a new *Perkin Elmer TriCarb 3170TR/SL* device is available. At the time of the visit a *Packard 2550 TR/AB* device was present but marked 'out of order'. Staff informed the verification team that the 'older one was better'.

The lab uses *QuantaSmart* software for QM. The team was told that using this software recently a technical problem was detected with one of the devices; but it could be quickly resolved.

Calibration for total beta measurements is done using KCl. The standards are produced at the laboratory; they are very well prepared, very homogeneous. For total alpha calibration natural uranium is used (0.2 g per planchette).

Sample preparation for LSC for H-3 is by mixing 10 ml water and 10 ml scintillator (*Ultima Gold LLT*); for C-14 determinations 10 ml *Permafluor* is used as scintillator with 10 ml *Carbosorb*. Background water for H-3 comes from deep boreholes at the *Mochovce* NPP.

The reference manuals and the catalogues were available for consultation during the visit of the EC team.

For alpha spectrometric measurements the laboratory has three vacuum chambers available that are currently equipped with PIPS detectors of 300 to 900 $mm^2$ surface. Samples are prepared by microprecipitation on *'Pall'* filters, a system developed by Comenius University. The sample number is marked on the sample. The lab does not use electrodeposition on disks (steel, Ag or Pt), the method that is currently used by the Comenius University lab.

*Gamma spectrometry*

The laboratory operates seven HPGe detectors (including one mobile device) from *Canberra* and *PGT*; relative efficiencies are 40-50%; resolution is 1.9 keV.

For two detectors one large steel shield is available (manufactured by *Vítkovice*; consisting of 20 cm thick steel, specially melted, with Sr and Co separated; the same steel is also used at the Comenius University laboratory), four detectors are installed in 'regular' Pb shields. Detector end caps are protected with plastic to avoid cross-contamination.

NIM electronics are from *Canberra*. Gamma spectroscopy software is *Canberra Genie 2000, Version .06*; the laboratory specialist evaluated the system as being very usable, with the exception of calibration information for analysis: there is no space for putting such information in the descriptive file. For inputting data into the data base the laboratory developed a very efficient user form (based on *MS EXCEL*).

Various geometries are calibrated: aerosol filters (pressed tablets, 1.6 cm high); 5.5 cm diameter cylinders with different heights and weights; 10 cm diameter cylinders with various heights and weights; 1 l Marinelli beakers. The laboratory also applies *Canberra ISOCS*. Its use is automated; analysis reports are automatically transferred to the database.

Calibration for aerosol filters and Marinelli geometry is done using a mixed radionuclide source purchased from *ČMI-IIZ*, Czech Republic.

Efficiency and energy checks were formerly done once per week. Due to the very high stability the frequency could be changed to once every two months. Background spectra are collected twice per year.

Liquid nitrogen is filled every week for detector cooling; *Messer Griesheim Apollo* cryotanks serve as reservoirs.

With regard to the operation of the mobile system it was explained that all necessary items are prepared and available in the lab (detector, *Canberra Inspector 2000* system) and will be moved to the car when needed. The new emergency car however will have a 'permanent' solution.

*Devices in the 'garden'*

In the garden area behind the laboratory building the team verified the presence of a fallout sampler (sampling surface 0.81 $m^2$, 10 cm high; flat), somewhat overshadowed by a tree.

In a container placed among the trees a HiVol aerosol sampler plus monitor is installed. Air flow rate is ca. 180 $m^3$/h. The device is equipped with a *Siemens* side channel blower, large cellulose filter, a plastic scintillator for beta measurement. Flow rate measurement is done with a rotator *VF s.r.o.*, *Zilina*. Flow rate calibration was done three years ago; checks and recalibrations are done when needed. The sampler has *DIN*50 tubing, the geometry guarantees sufficient laminar flow. Generally, some 6000 $m^3$ are collected. Air temperature and air pressure are not measured, thus no determination of Norm-$m^3$ is possible.

As an emergency monitor a radio-iodine measurement system (*Canberra*, aerosol pre-filter, iodine cartridge, NaI(Tl) measurement) is also installed in the container; it can be turned on/off remotely from the teledosimetry room.

Outside the container the team observed the presence of a gamma dose rate detector (same system as at the NPP, mounting height 3 m, collimator) between trees.

*Quality Management*

The laboratory is not accredited to ISO17025. Some steps have been taken in direction of accreditation, however laboratory personnel is not sure when the project can be concluded.

For specific analyses samples can be handed over to other (accredited) laboratories. E.g. for groundwater samples there are two subcontractors that perform the tasks: *EKOSUR* (sampling, collection and evaluation) and Comenius University at *Bratislava* (sample preparation and measurement). The measurement results are reported to the laboratory that evaluates the values using a specific model. A report is sent quarterly by the NPP to *EKOSUR*.

Every one to two years the laboratory participates in international and national inter-comparisons for tritium and for alpha and gamma emitter determinations.

NPP policy requires calibration of the measurement devices every two years. In addition, every two years all measurement equipment is checked by the Slovak Metrological Institute.

*Archiving*

Measurement data are automatically transferred from the measuring device to *'ARSOZ'* (the according interface was created in the lab). Some data, e.g. for gamma spectra, are kept in the local computer, a copy e.g. of the gamma spectrum is also placed on the server; all final data are transmitted to the server (using a microwave data connection to the NPP via *VÚJE a.s.*, a company at *Trnava*). Monthly, DVDs are produced as backup. Paper versions are stored for five years.

Non-destructively analysed samples (grass, aerosols, agricultural products) are also archived for five years.

*Reporting*

Basic reports are done quarterly; yearly a complex report is drafted.

Some data are exported to other bodies, e.g. *SHMÚ* (once per month), the Crisis Coordination Centre at the Nuclear Regulatory Body, and the emergency centres of the NPP and the support centre.

*The verification team encourages pursuing the process of accreditation of the laboratory according to ISO 17025.*

*With regard to gross alpha and beta measurements the verification team suggests storing the (natural) standards in exsiccators with a view to avoid possible deterioration of their homogeneity.*

*The verification team suggests exploring the possibility to apply the same sample preparation procedure for alpha spectrometry as the laboratory at Comenius University with a view to methodological harmonisation and better comparability of results for 'same' samples.*

*With regard to the sampling and monitoring devices in the garden, the verification team suggests finding locations for placing the fallout sampler and the dose rate probe that are less protected by trees.*

# 7. NPP - INDEPENDENT CONTROL BY THE REGULATOR

The supervisory authority participates in the process of discharge monitoring by means of reviewing the monitoring plan within the authorization process of a nuclear facility, the specification of limits for radioactive discharges and the specification of conditions for the operation of a nuclear facility. The licence for the operation of a nuclear facility is issued by the Public Health Authority of the Slovak Republic only if the monitoring plan enables to evaluate the effect of the operation on the environment in a required range. Within the scope of the state health surveillance in nuclear facilities the Public Health Authority (PHA) controls compliance with the monitoring plan and the results of the monitoring.

During inspection, the results of measurements, measurement devices' conditions, metrological verification, calibrations, compliance with methodology, sample information and measurement results records are controlled. The supervisory authority carries out control measurements for example of discharge water, water from collecting vessels before discharge, and aerosols. Regarding the monitoring in the surroundings of the nuclear facilities, PHA collects samples and performs measurements and evaluations. Especially, surface and drinking water, sediments, water plants, fallout, soil, agricultural products and feed contamination and milk are controlled. The range of these measurements is significantly less than the range of measurements carried out by the operator.

The verification team was told that with regard to NPP discharge samples for V1 and V2, the samples are kept 'on hold' on site, in a shielded place, for any control by the regulator: Aerosol samples are stored since 2007, evaporated liquids are kept for three months, raw liquids for one month (volume of ½ litre). The samples may be taken by the regulator's inspector at any time. Formerly, the regulator took one sample per month; now this is done only occasionally. The team was told that this is because the regulator's laboratory currently has a capacity problem for gamma spectrometry and because H-3 measurements are avoided due to an elevated risk of contamination in the laboratory.

With regard to the tritium contaminated ground water issue the team was informed that drinking water for the local municipal water supplies comes from the area of *Piešťany*. There is a recommendation not to use local wells; the local population is informed in this respect. However, ground water is used for irrigation.

Also the regulatory control with regard to environmental samples is provided by the PHA laboratory in *Bratislava*. The team was informed that, however, few samples can be taken and analysed due to understaffing and lack of measurement devices.

> *The verification team strongly recommends the regulator setting up and running a control system that allows doing checks on several percent of the – aerial and liquid – discharge samples, both for gamma spectrometric determinations as also for the measurement of H-3 and other radionuclides. Also the environmental monitoring should be re-established in such a way that it allows representative measurements and realistic dose estimates.*

## 7.1. PUBLIC HEALTH AUTHORITY (PHA) *BRATISLAVA* – VERIFICATION ACTIVITIES

The Public Health Authority's premises at Bratislava were not part of the current verification visit. However, based on talks with regulator staff during the visit of the *Jaslovské Bohunice* NPP and its surroundings several items with regard to the work of PHA could be discussed.

Compared to the verification in 2005, the legal basis for radiological monitoring and the respective tasks of PHA have changed. A new law defines the responsibilities of the ministries; a new regulation – following the EU recommendation – is in place dealing with the monitoring network; the monitoring plan is based on it.

The law only defines that an agreement with regard to the monitoring tasks has to be in place. A specific Parliamentary Act serves as legal basis for the Hydrometeorological Institute; with regard to the monitoring plan it has to follow the regulation.

Radioactivity monitoring is excluded from the general Environmental Protection Act. Foodstuff control still belongs to the veterinary area (i.e. to the Ministry of Agriculture, with measurement tasks

e.g. at its institute in *Nitra*); however PHA has recently taken over some radioactivity monitoring for meat.

With regard to the NPP, the regulation stipulates that the regulator has access to necessary operator data (online). Currently this is possible only at the Nuclear Safety Agency. The verification team was told that the NPP operator is willing to allow PHA access, but the regulator hesitates due to cost reasons.

Generally, with regard to the work of the Public Health Authority the verification team realizes that not all data available at various bodies in Slovakia that would seem useful for the work of PHA are transmitted to this authority. In particular, this seems to concern the air monitor device located at the meteorological station near the *Jaslovské Bohunice* NPP (verification see chapter 8.1.), for which the radiation protection regulator does not have direct data access. The authority receives monthly averages of the results of this system (direct data access is available for the Nuclear Regulator and the Hydrometeorological Institute). For other measuring devices (apparently including a gamma dose rate monitor, also located at the meteorological station near the *Jaslovské Bohunice* NPP) no automatic data transmission is foreseen. Many monitoring systems for environmental radioactivity use web based applications for data presentation; thus direct access to such data should be easy to achieve.

*The verification team recommends the (radiation protection) regulator to ensure direct and efficient access to all (environmental) radiological data with a view to have relevant data quickly available when needed.*

## 7.2. THE REGULATOR'S LABORATORY

The PHA laboratory in *Bratislava* was visited by an EC verification team in 2005 and was not part of the current verification. However, the team received information on the work status and ongoing problems at the laboratory that obviously severely impede a reasonable surveillance of the NPP sites in Slovakia, both with regard to the control of radioactive discharges as with regard to environmental monitoring.

The verification team was informed that the laboratory's programme with regard to the *Jaslovské Bohunice* NPP covers gamma spectrometric measurements of soil, feed, vegetable, fruit, cereals as well as surface water from the canal and *Dudváh* River sampled by personnel from the lab.

The lab is equipped to perform determinations of gross beta, gross alpha, Sr-90, U, Ra, Rn, H-3, K-40 (by gamma spectrometry), as well as of Cs-137 and I-131 (by radiochemical sample preparation and beta measurement). Previous to the mission, the team received detailed information concerning the equipment of the laboratory.

Based on this information, the team noted that since the verification visit in 2005 the radiochemistry unit improved its capacity (for example by receiving a new *FHT* alpha/beta measuring device). However, for gamma spectrometry, only one person nearing retirement is currently available. Thus, discharge samples are analysed by gamma spectrometry only when a specific reason exists.

For dose measurements the laboratory has access to a *Harshaw* TLD reader from another lab when needed.

The team was also told that the laboratory hesitates to perform tritium measurements on samples from the NPP since it fears contamination of the measuring device used for environmental samples. Apparently a separate device dedicated to samples with potentially higher tritium activity is not available.

The team was also informed that at a recent inter-comparison exercise the laboratory failed to reach adequate analysis results. The team was not informed about details and thus cannot comment on this subject nor phrase an appropriate recommendation.

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

*The verification team strongly recommends establishing the necessary conditions with regard to personnel and equipment needed for a reasonable surveillance of the Slovak NPPs by the regulator.*

## 7.3. SLOVAK ENVIRONMENTAL RADIOACTIVITY MONITORING

The organisations taking part with their respective laboratories in the national monitoring programme for environmental radioactivity are PHA and *SHMÚ*. At some locations sampling is performed at the same sites where the NPP operator (for the *Jaslovské Bohunice* NPP the laboratory *LRKO-SE*) collects samples.

### 7.3.1. Environmental gamma dose monitoring

The department of Health Radiation Protection of the PHA provides the integral dose measurements using TLDs (lithium fluoride dosimeters) in western Slovakia, at 46 sites with a distance of up to 100 km from the *Jaslovské Bohunice* NPP. The probes are exchanged and read in three-monthly intervals. For measurement a *HARSHAW 3500* TLD reader is used.

### 7.3.2. Nationwide air and dose rate monitoring system

The Slovak Hydrometeorological Institute (*SHMÚ*) plays the most important role regarding the radiation monitoring network at national level. *SHMÚ* integrates the national meteorological service, the national hydrological service and the national air pollution service.

The radiation monitoring network of the Slovak Hydrometeorological Institute as a system of early warning is part of the radiation monitoring network of the Slovak Republic (see Appendix 5; this appendix also indicates the locations of the devices operated by Civil Protection and by the Slovak Army). In 26 meteorological stations 26 gamma dose rate probes and four aerosol samplers/monitors are installed. Some of the devices are situated in the surroundings of the Nuclear Power Plants *Jaslovské Bohunice* and *Mochovce*.

In 2002 the old detectors *FAG FHZ 621B* were completely replaced by *Genitron GammaTracer* devices. Since 2008 at three monitoring sites new devices (type *RPSG-05* from *MicroStep-MIS*, Cavojskeho 1, 84104 Bratislava 4, Slovakia) are in test operation. Data from the three new detectors are inserted to the new *ORACLE* database that in the near future will include all gamma dose rate data.

The detectors are verified every two years and calibrated every four years. The Slovak Institute of Metrology performs this action in compliance with the national legal calibration plan.

*SHMÚ* operates three aerosol sampling stations, in *Hurbanovo, Stropkov and Liesek*. Nominal flow rate is 200 $m^3$/h. At these stations, filters are exposed one week per month; they are then sent to the Public Health Authority laboratories for analysis (Cs-137, Be-7). On a national, bilateral basis ambient gamma dose rate data are exchanged off-line between *SHMÚ*, the Slovak Army, the Ministry of Health, the Slovak Nuclear Power Plants and Civil Protection. A common platform has been created for data processing, analysis and comparison, leading to a unified database. The results are presented in common annual reports.

Since 1998 *SHMÚ* cooperates with the European Commission Joint Research Centre (EC JRC) at *Ispra*, Italy, in the frame of EURDEP (European Union Data Exchange Platform). In 2008, a Memorandum of Understanding between EC JRC and *SHMÚ* was signed in this respect.

The data exchange process uses the EURDEP 2.0 format from 1.12.2002. A new format (EURDEP XML) is currently being prepared. Every hour the data from the Slovak monitoring network are stored on the ftp server of *SHMÚ*; from where subsequently the data are sent to the database at *Ispra*.

### 7.3.3. Monitoring in the vicinity of *Jaslovské Bohunice* NPP

An overview of the environmental samples taken by PHA in the vicinity of the Slovak NPPs is shown in table 1. With regard to various sampling and measuring tasks, near the *Jaslovské Bohunice* NPP the Hydrometeorological Institute *SHMÚ* operates a large meteorological garden.

Table 1: Environmental samples taken by PHA in the vicinity of the Slovak NPPs

| Sample type | Sampling localities in the vicinity of the NPPs *Jaslovské Bohunice* and *Mochovce* | Sampling frequency | Measurements |
|---|---|---|---|
| Wet and dry fallout, rainfall | 4 | monthly | Sr-90, Cs-137 (quarterly), H-3, gross beta (monthly) |
| Water (drinking, surface, waste) | 14 | monthly | Sr-90, Cs-137, H-3, I-131, gross alpha, gross beta (monthly), Rn-222, Ra-226, $U_{nat}$ (on demand) |
| Milk (fresh cow) | 9 | monthly | Sr-90, Cs-137 |
| Cereals (wheat, barley) | 16 | yearly | Sr-90, Cs-137 |
| Forage | 19 | yearly | Sr-90, Cs-137 |
| Crop soil | 8 | yearly | Sr-90, Cs-137 |
| Vegetables, fruit, other foodstuffs | 18 | yearly | Sr-90, Cs-137 |
| Water plants, sediments | 14 | yearly | Sr-90, Cs-137 |
| Others (moss, mushrooms) | 4 | yearly | Cs-137 |

For example, tap water is collected at *Jaslovské Bohunice* on a monthly basis. The quantity collected is 5 litres. Analysis is for Sr-90, Cs-137, H-3, Rn-222, Ra-226, natural uranium, gross alpha and gross beta.

With regard to soil, at *Jaslovské Bohunice*, within an area of one square meter, five samples are taken from a layer of about 5 cm depth, one at each corner and one in the middle of the delimited area, using a special stainless steel shovel. Sampling is once a year.

In *Jaslovské Bohunice* sampling of feed is done directly in the fields during the harvesting season. Once a year, a quantity of 5 kg is taken manually or with scissors. The measurements performed are for Cs-137 and Sr-90.

With regard to cereals, spot sampling at farms has been organized. Yearly a quantity of 5 kg of the respective produce is taken for the analysis of Cs-137 and Sr-90.

#### 7.3.3.1. *SHMÚ* meteorological site near the *Jaslovské Bohunice* NPP

In the direct neighbourhood of the NPP (a few hundred metres SW) the Slovak Hydrometeorological institute (*SHMÚ*) owns a piece of land of about 1 ha that houses among others several devices for sampling and measuring related to the authorities' surveillance of the NPP.

On the basis of a bilateral agreement between the Austrian Ministry of Agriculture, Forestry, Environment and Water-Management and the Slovak Ministry of Environment Slovakia received an automatic air monitor type *AMS-02, Bitt Technology*, *Spillern,* Austria, including container and weather station. Nominal air flow rate is 6 $m^3$/h. The monitor was installed at the meteorological station on 4 October 2001. This device is taken care of by *SHMÚ*.

Also a gamma dose rate detector type *GammaTracer* from *Genitron*, Germany, is installed at this site, belonging to *SHMÚ*'s dose rate monitoring network.

PHA installed a TLD device at the site; it also operates a deposition sampler at this location. The device consists of a stainless-steel cylinder vessel with a diameter of 20 cm. During the dry season 1 l of distilled water is added, during winter ethanol. Sampling is done monthly. The measurements performed are for Cs-137, Sr-90, H-3, gross beta (monthly) and residual beta (quarterly).

PHA has an agreement with *SHMÚ* for the operation of the TLD device and the fallout sampler, as well as with regard to receiving the results of the air monitor (albeit not directly).

#### 7.3.3.2. Other radiological monitoring stations of the authority

Another radiological monitoring station is situated at the premises of the aviation meteorological station, located at *Piešťany* airport, 30 km north-east from the *Jaslovské Bohunice* NPP. The verification team did not visit the station.

At the *Bratislava-Koliba* meteorological station which is situated in the hills near *Bratislava*, 53 km from the *Jaslovské Bohunice* NPP, and also houses the Data Centre for radiation monitoring of *SHMÚ*, a *Bitt AMS-02* automatic air monitor and a gamma detector are installed. The automatic air monitor is operated in cooperation with the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. PHA operates a deposition sampler (same type as described in Chapter 7.3.3.1) at this location. The verification team did not visit this station (it was part of the Art. 35 verification in 2005).

At the *Trenčín* airport aviation meteorological station located 75 km north of the *Jaslovské Bohunice* NPP, a new *Microstep-MIS RPSG*-05 gamma detector was recently installed. The verification team did not visit that location; but was informed that the device was in test mode at the time.

Still another gamma detector is installed at *Nitra* airport aviation meteorological station located 60 km south-east from the *Jaslovské Bohunice* NPP. The verification team did not visit the station.

### 7.3.4. Data management and exchange

For the Slovak Republic, the data from all detectors of the automated meteorological stations situated in the vicinity of the NPP are transmitted by data logger through the *SHMÚ* network to the National Telecommunication Centre in *Bratislava*. Every 10 minutes the data (gamma dose rate and precipitation) are transferred to the database. Regular automatic data backups are performed by the server. The radiation data files are transmitted on-line from *SHMÚ*'s network to the information system of the Nuclear Regulatory Authority of the Slovak Republic and to the information system of the Slovak Army. At the time of the visit the transmission to the Crisis Centre for Civil Protection in *Bratislava* was stopped due to upgrading.

For the radiation monitoring system there are two backup servers. The data base uses *MS SQL 7.0*. The database contains one table for radiation data and several tables for configurations, catalogues of stations and additional information. Based on SQL scripts the database produces reports in several formats. Time series for the monitoring sites are analysed using statistics software (*STATISTICA 8.0*) and are integrated into the reports. All annual data reports are presented on the web page of Environmental Monitoring of Slovak Republic (in Slovak language). This site is operated by the Slovak Environmental Agency.

The data between *SHMÚ* and the Austrian Federal Radiation Warning Centre in Vienna are exchanged using directories on the ftp-server of *SHMÚ*. Every 10 minutes data from 336 Austrian stations are transferred to an 'in' directory on the *SHMÚ* ftp server and are then inserted into the radiological database. Similarly, every 10 minutes the data from the Slovak monitoring network are transferred to an 'out' directory on the ftp server and then down-loaded by the Austrian data centre. EURDEP version 2.0 is used as the format for data transfer.

On the basis of an agreement between the Hungarian Ministry of the Environment, the Hungarian Ministry of the Interior and the Slovak Ministry of Environment, *SHMÚ* started a data exchange with the Hungarian meteorological service in mid-2002. For this purpose a fixed data transmission line *Bratislava – Budapest* with a capacity of 16 kbit/s was leased. The data between *SHMÚ* and *Meteoservice Hungary* are transmitted via the Regional Meteorological Data Communication Network. The data files with the radiation data in EURDEP 2.0 format are exported from the *SHMÚ* database every 10 minutes and are then uploaded to the server at *Meteoservice Hungary* and vice-versa for Hungarian data.

In cooperation with the Hungarian National Directorate-General for Disaster Management in-situ measurements are done at all *SHMÚ* monitoring points.

With regard to the air monitor at the meteorological station in the vicinity of the NPP, since three years there is a continuous exchange of data between the Slovak Ministry of Environment and the Austrian Ministry of Agriculture, Forestry, Environment and Water-Management. At present the national monitoring centre in *Bratislava-Koliba* is connected to the *Jaslovské Bohunice* NPP and to the Austrian data centre via an ISDN line providing the data exchange.

# 8. THE SLOVAK RADIOLOGICAL DATA MANAGEMENT FACILITIES WERE NOT PART OF THE VERIFICATION VISIT.VERIFICATION OF OFF-SITE SAMPLING POINTS (OPERATOR AND REGULATOR)

Some of the sampling points covered in this chapter are used by both, the operator and the authorities. With regard to the technical details no distinction is made.

## 8.1. *SHMÚ* – HYDROMETEOROLOGICAL INSTITUTE STATION NEAR THE NPP

The verification team visited the meteorological station, located some 200 m SW of the NPP site, and found it very well placed, totally free, without any obstacles. The area belongs to the Slovak Hydrometeorological Institute (*Slovenský hydrometrologický Ústav, SHMÚ*). Also offices of *EKOSUR* (a company involved in the monitoring tasks) are located here.

The site contains a meteorological mast (height 103.5 m) and a meteorological garden containing various sampling and measuring devices.

*Fallout samplers*

The verification team noted two stainless steel pots, mounted some 50 cm apart on a single metal frame serving as samplers for dry and wet precipitation. They are owned by PHA.

*Gamma dose rate*

A *Genitron Gamma Tracer* dose rate detector ('wide' version; serial number GF1232) is mounted on a metal holder, the 'active' part being 1 m above ground. The team was told that it belongs to the *SHMÚ* gamma dose rate network. The version installed covers a measuring range from 20 nSv/h to 10 Sv/h and a temperature range of -30 to +50 °C. It has an RS232 connection by cable to a *Vaisala Milos 500* automatic weather station, which is part of the national system operated by *SHMÚ*.

*Gamma dose*

The team noted a TLD (LiF) device, owned and looked after by PHA which was mounted in a meteorological cabin and is changed quarterly.

*Air monitor*

In a locked container at a distance of some 10 metres from the large meteorological mast a type *AMS-02* air monitor (*Bitt Technology*, *Spillern*, Austria) is installed, with a *Bitt RS03/X* dose rate probe and a small meteorological mast mounted on the roof. The key to the container was available for the visit.

In 2000, an agreement between the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management and the Slovakian Ministry of the Environment turned this monitor over to the Slovak Ministry of Environment. At present SHMÚ is the operator and owner of this device.

The device offers alpha/beta and gamma measurement of aerosols during sampling (glass fibre filters), as well as measurement of elemental radioiodine with delay and of organic radioiodine in a bypass system.

The version installed is equipped with high resolution gamma spectrometry for aerosols (*Ortec* HPGe detector with electrical cooling using an *Ortec X-Cooler II* and an *Ortec CryoSecure* device). Alpha/beta measurement is done with a PIPS detector; elemental iodine is measured with a NaI(Tl) detector and special paper filters with active carbon impregnation. The bypass for the measurement of organic iodine operates with a NaI(Tl) detector and an Ag-activated silica gel column in Marinelli geometry; it is automatically turned on when elevated measurement values of one of the other devices occur. Glass fibre and paper filter movement is controlled by a robotic system; the filter racks include several calibration/check sources. All relevant data are communicated to the data centres (in Slovakia and in Austria).

The container has air conditioning and a UPS to guarantee electric current. Intruder control with alarm function is available; however it could not be verified where alarms are sent to.

PHA staff accompanying the verification team was not informed about details of the device, since all necessary technical and administrative contacts with the Austrian counterparts are via *SHMÚ*.

Software maintenance and service of the device is done by *Bitt Technology*, mostly remotely from the company headquarters in Austria via telecommunication. Technicians of the firm come regularly for hardware maintenance and when needed for repairs.

The verification team noted that the gamma dose rate probe on the roof is mounted in the 'standard' way, i.e. on a tripod, ca. 70 cm above the container roof.

> *The verification team suggests investigating if the gamma probe on the container roof can be installed in such a way that the 'centre' of measurement is 1 m above ground (which would reflect the way most gamma dose rate probes in European dose rate monitoring networks are mounted).*

## 8.2. MILK FARM

The verification team visited a large milk farm at *Pečeňady* (*Poľnohospodrérske družstvo*) where 70 cows are stabled. Milk is kept in a 1250 l cooled tank. Every Monday morning a one-litre sample is taken from the morning milking (after stirring).

The team was informed that there are two milkings per day; the overall daily production is 900 l milk. The cows are fed on silage of local origin.

After transport to the laboratory the samples are stored in a refrigerator (without stabilizer) to avoid sample deterioration.

> *The verification did not give rise to specific remarks.*

## 8.3. OTHER SAMPLING LOCATIONS

The verification team visited the following sampling locations, most of them situated in an easterly direction from the NPP:

*Dudváh River, near Bucarny*

At this location surface water, sediment and water plant samples are taken. The water is taken from a bridge by means of a bucket; sediment samples are taken below the bridge.

No information on the water flow rate is available.

The team was informed that operator and regulator sample at the same location.

*Field near Žlkovce*

At the edge of a field near *Žlkovce*, protected by trees, the team saw the operator's ground water borehole no. SK-1. The pipe is covered to avoid soiling and locked to prevent vandalism. The team was informed that the borehole depth is 10 m, the water level being at 3 m.

*Manivier Canal in Žlkovce*

At this location, near the bridge on the main road, surface water, sediment and water plant samples are taken.

*The verification did not give rise to specific remarks.*

## 9. A-1 REACTOR ACCIDENT IMPLICATIONS

The reactor A-1 (also referred to as KS 150) was the first nuclear power reactor in former Czechoslovakia. It had a capacity of 3x50 MW (three turbines), used natural uranium as fuel, heavy water as moderator, and carbon dioxide as coolant. Thus its classification was HWGCR. Construction started in 1958, commercial operation in 1972. The reactor was of – rather experimental – USSR design, however construction was fully by *Škoda Plzeň*. Using natural uranium (without enrichment) was seen as major advantage, Czechoslovakia having uranium mines and production sites of its own.

During operation of the power plant two serious accidents happened, both during fuel exchange.

The first accident occurred on 5 January 1976, during regular fuel exchange, as a result of a technical failure. A fresh fuel assembly was expelled from the reactor into the reactor hall. $CO_2$ gas escaped through the now open fuel channel, leading to a drop-off of $CO_2$ pressure and thus problems with cooling of the active zone of the reactor. This resulted in fuel damage and release of fission products into the primary circuit. Finally the reactor cooling could be re-established. The operation of A-1 was restarted and continued until a second operational accident occurred.

This accident, on 22 February 1977, also happened during regular fuel exchange, however due to a combination of a design flaw and human error. It was later classified as level 4 on the INES scale. The personnel had left remains of “silicagel" (used as anti corrosion appliance) in a fuel assembly. This fuel assembly was loaded into a fuel channel. Consequently, the silicagel partly blocked the passage of cooling gas which caused overheating of the fuel assembly, thus melting its shroud tube. The damage resulted in the penetration of heavy water into the gas cooling cycle. A sharp increase of humidity in the primary cycle caused damage of the cover of all fuel assemblies in the active zone. Thus the primary circuit was radioactively contaminated; leakages in the steam generators lead to contamination of the secondary circuit.

Due to the estimated high costs, repair of the damages was not envisaged. A decision was taken to leave the NPP in shut down mode; it is currently in the first stage of decommissioning. The spent fuel from this plant was removed and transported to the Russian Federation.

The first phase of the decommissioning project covers an assessment of the radiation safety status. Considerable work has been assigned to *VÚJE* a.s., a company working in the nuclear area, as general supplier for *JAVYS*.

The next phases of decommissioning were foreseen to start in 2009 and will last until 2033. They will consist of a continuous decommissioning of the A-1 reactor, starting with the less contaminated areas and equipment and then turning to the large areas and equipment with highest contamination. Environmental monitoring of releases from A-1 will be linked to the environmental radioactivity measurements for the V1 and the V2 reactor as performed by *LRKO-SE*. Besides that, the A-1 NPP has its own on-site monitoring systems for releases to the environment (airborne and liquid).

Nowadays, besides ground water contamination with tritium, contamination of the environment can be found only on the banks of river *Dudváh*, a river that is connected to the NPP site by the *Marivier* Canal and flows into the larger *Váh* River. In several places, Cs-137 and Co-60 and traces of plutonium and americium were found (for details see below). Some monitoring reports delivered by *VÚJE* a.s. include the proposal to clean some spots at the river *Dudváh*.

The verification team received a detailed presentation on the way the decommissioning is organized. The main managerial workload is associated to *JAVYS* (*Jadrová a vyraďovacia spoločnosť, a.s*; Nuclear and Decommissioning Company). Generally, its activities cover

- V1 NPP operation termination and decommissioning preparation;

- A-1 NPP decommissioning;
- radioactive waste management;
- spent fuel management;
- new NPP build preparation.

The company started its activities on 1 April 2006; it's only shareholder is the Ministry of Economy. It currently has 1186 employees. *JAVYS* provides its services on a contract basis.

Another contractor for the NPP is *EKOSUR*, a private company working in the nuclear and radio-ecology area. With regard to the NPP site it provides activities in particular with regard to ground water contamination analysis and remediation (mainly for tritium) as well as with regard to soil contamination. In this respect it produces five reports yearly (four quarterly and one annual).

The verification team was informed that before 1992 liquid discharges from the NPP site were led via the 5.5 km long *Manivier* Canal to *Dudváh* River that after 12 km flows into the river *Váh*. Since 1992 the waste waters are discharged via a shorter new underground tunnel to river *Váh*.

The team was further explained that after heavy rainfalls in 1979 all the basements of A-1 (including tanks and spent fuel storage areas) were flooded. Water thus contaminated, together with soil and mud, ran off to the rivers contaminating some 20 km of the river banks. At that time, no legislation enforced decontamination of such areas. The team was told that Cs-137 contamination measurements along the *Dudváh* River showed values up to 6.8 Bq/g on the river banks and up to 25 Bq/g at hot spots. Presently, these spots are not access protected.

Measurements of contaminated soil are still performed along the *Manivier* Channel and *Dudváh* River at present. Remediation measures for contaminated sites are discussed. In this context, the team was told that between 1994 and 1996 the NPP projected an action to collect contaminated soil from the whole area; it was planned to store the soil in the vicinity of the V2 unit.

*The verification team encourages all measures aimed at keeping the population exposure due to the tritium contamination as low as reasonably achievable. It recommends implementing remediation of the contaminated sites along the Manivier Channel and Dudváh River. It also encourages continuing all efforts to implement the decommissioning process of A-1, in particular with a view to minimize (long term) radiation exposures.*

## 10. 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 conclusions:

(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 around the site of the *Jaslovské Bohunice* NPP as well as on the territory of the Slovak Republic (as far as included in the verification) are adequate. The Commission could verify the operation and efficacy of a representative part of these facilities.

(2) Several recommendations have been formulated, in particular with regard to the control of the operator by the regulator and availability of data to the regulator. Some suggestions, mainly in relation to quality assurance and quality control, have also been made. These recommendations and suggestions aim at improving some aspects of the environmental surveillance. They do not detract from the general conclusion that discharge monitoring at the *Jaslovské Bohunice* NPP and the monitoring of environmental radioactivity in the surroundings of that NPP as verified by the team are in conformity with the provisions laid down under Article 35 of the EURATOM Treaty.

(3) The verification findings and ensuing recommendations are compiled in the 'Main Findings' document that is addressed to the Slovak competent authority through the Slovak Permanent Representative to the European Union.

(4) The Commission services ask the Slovak competent authority to inform them of any progress or significant changes with regard to the situation at the time of the verification. In particular, they will closely follow up the progress made with respect to point (2) above. The Commission services may decide to conduct a re-verification in due time.

(5) The present Technical Report is to be enclosed with the Main Findings.

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

## APPENDIX 1

**REFERENCES, DOCUMENTATION AND WEB SITES USED**

### 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.
- Act Nr. 355/2007 Coll. from 21 June 2007 on Protection, Support and Development of Public Health.

### 2. Public Health Authority

- Filled in questionnaire;
- Maps showing sampling sites etc..
- Various documents on A-1 accidents

### 3. SE, ENEL

- Advance Information Package, in particular: General Information; Monitoring Programme; Spectrometric laboratory of radiation protection in SE EBO; EBO environment radiation monitoring programme;
- Power Point Presentations on V2.

### 4. JAVYS

- Documents and presentation on decommissioning and monitoring related to A-1.

### 4. EKOSUR

- Presentation on groundwater monitoring and remedial measures.

### 5. Web sites

| | |
|---|---|
| Ministry of Health | http://www.health.gov.sk |
| Ministry of the Environment | http://www.enviro.gov.sk |
| PHA | http://www.uvzsr.sk |
| Nuclear Regulatory Authority of the Slovak Republic | http://www.ujd.gov.sk |
| Slovak Hydrometeorological Institute | http://www.shmu.sk |
| Slovak Environmental Agency | http://enviroportal.sk/ism/spravy.php |
| SE ENEL | http://www.seas.sk |
| *JAVYS* | http://www.javys.sk/sk/index.php |
| *EKOSUR* | http://www.ekosur.sk/ |
| *Genitron* | http://www.genitron.de/products/products.html |
| *Microstep* | http://www.microstep-mis.com/index.php?lang=en&site=src/products/radiation_monitoring |
| *Bitt Technology* | http://bitt.at |

## APPENDIX 2

### THE VERIFICATION PROGRAMME – SUMMARY

**Monday 8/6**

1. Arrival at the Jaslovské Bohunice NPP site - site access formalities (AM).
2. Opening meeting: introductions / presentations / programme of the visit (AM).
3. Discharge team: Verification of the regulatory provisions for monitoring/sampling of radioactive discharges of one of the V2 reactors (aerial and liquid) and visit of the reactor's operations' control room (PM).
4. Environment team: Verification of a representative selection of the site-related provisions for environmental monitoring/sampling (**on-site** Jaslovské Bohunice NPP) put in place by the operator (statutory obligations) as well as by the regulator (check monitoring) (PM).

**Tuesday 9/6**

5. Discharge team: Verification of aerial discharge control for one of the V2 reactors (all day)
6. Environment team: Verification of a representative selection of the provisions for environmental monitoring/sampling with regard to the **A-1 reactor** (on and off-site) (all day).

**Wednesday 10/6**

7. Discharge team: Verification of liquid discharge control for one of the V2 reactors (all day)
8. Environment team: Verification of a representative selection of the site-related provisions for environmental monitoring/sampling (**off-site** Jaslovské Bohunice NPP) put in place by the operator (statutory obligations) as well as by the regulator (check monitoring) (all day).

**Thursday 11/6**

9. Both teams: Presentation of the A-1 issue by Slovak representatives; common discussion (AM)
10. Discharge team: Verification of the operator's laboratory(ies) for discharge samples (PM).
11. Environment team: Verification of the operator's environmental monitoring laboratory (PM).

**Friday 12/6**

12. Discharge team: Verification of the regulator's discharge control related laboratory (AM).
13. Environment team: Verification of the regulator's environmental monitoring laboratory (AM).
14. Closing meeting: presentation of preliminary verification findings (PM).
15. Return travel to Luxembourg.

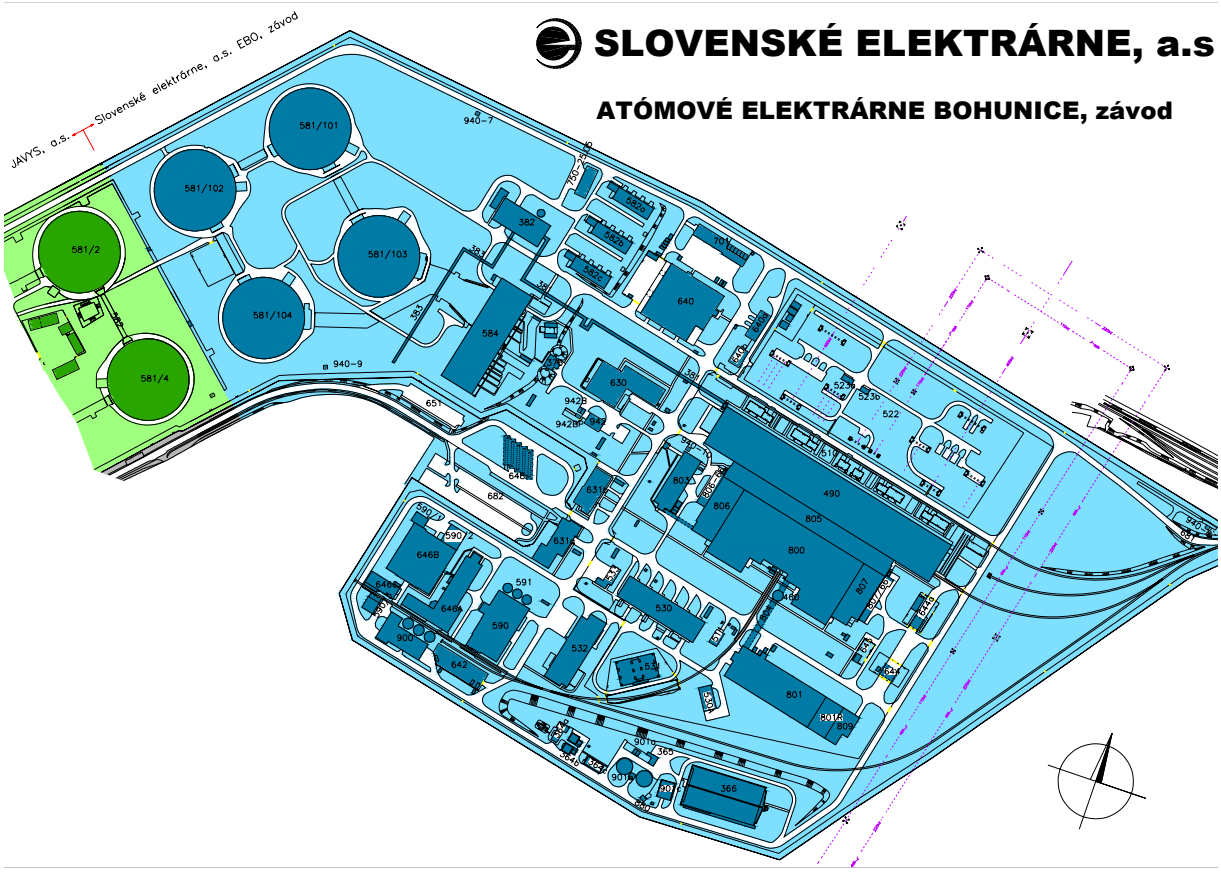
Discharge team: Jean-Loup Frichet, Eberhardt Henrich

Environment team: Constant Gitzinger, Adriana Godeanu Metz

Leader: Constant Gitzinger

APPENDIX 3

## *JASLOVSKÉ BOHUNICE* NPP, V2, MAP OF SITE



## APPENDIX 4

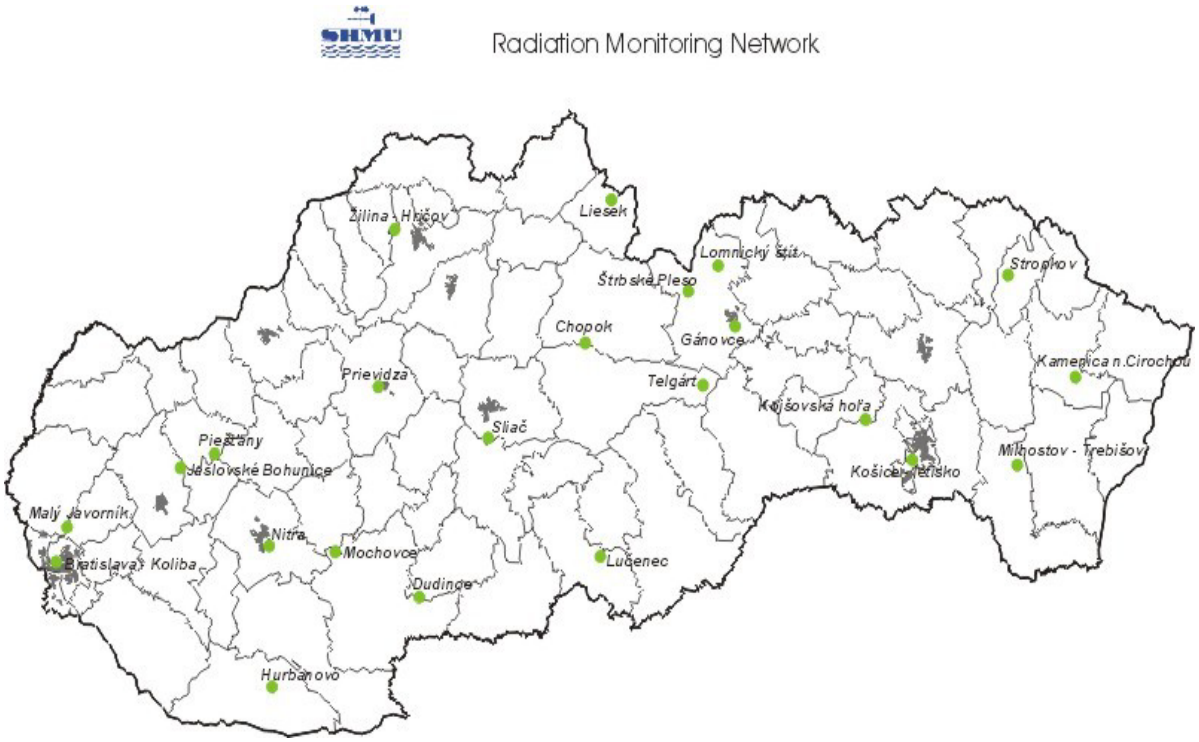
### LIQUID DISCHARGE RELATED MONITORING PROGRAMME *EBO-SE*

| | sample description | sample form | labelling | standard sampling | analysis periodicity |
|---|---|---|---|---|---|
| **Outlet pipeline building 880** | Average - sewerage channel V2, building no.880 | water | PW | daily | daily - β |
| | Immediate - sewerage channel V2, building no.880 | water | OW | Mon, Wed, Fri | Mon, Wed, Fri - β |
| | Accident - sewerage channel V2, building no.880 | water | PRW | operatively | operatively - β |
| | weekly poured sample | water | PW - weekly poured sample | weekly | weekly - H3 |
| | monthly poured sample | evaporate | PW - monthly poured sample | monthly | gamma - monthly |
| **Control tanks building 801** | Control tanks V2 | water from tanks | TR41, TR42, TD41, TD42, RY34 | before emptying | operatively - β, $H^3$ |
| | Control tanks V2 monthly poured sample | evaporate | KNDV2, poured | monthly | monthly - gamma |
| | Control tanks V2 quarterly poured sample | poured water from tanks | KNDV2, poured quarterly | quarterly | quarterly - transuranium<br>quarterly - strontium |
| **Control tanks building 803** | Control laundry tanks V2 | water from tanks | 17.1, 17.2, 18.1, 18.2 | before emptying | operatively - β, $H^3$ |
| | Control laundry tanks V2, small monthly poured sample | evaporate | KNP2M, poured | monthly | monthly - gamma |
| | Control laundry tanks V2, small quarterly poured sample | poured water from tanks | KNP2M, poured quarterly | quarterly | quarterly - transuranium<br>quarterly - strontium |
| | Control laundry tanks V2, big | water from tanks | 20.1, 20.2, 20.3 | before emptying | operatively - β, $H^3$ |
| | Control laundry tanks V2, big monthly poured sample | evaporate | KNP2V, poured | monthly | monthly - gamma |
| | Control laundry tanks V2, big quarterly poured sample | poured water from tanks | KNP2V, poured quarterly | quarterly | quarterly - transuranium<br>quarterly - strontium |

## APPENDIX 5

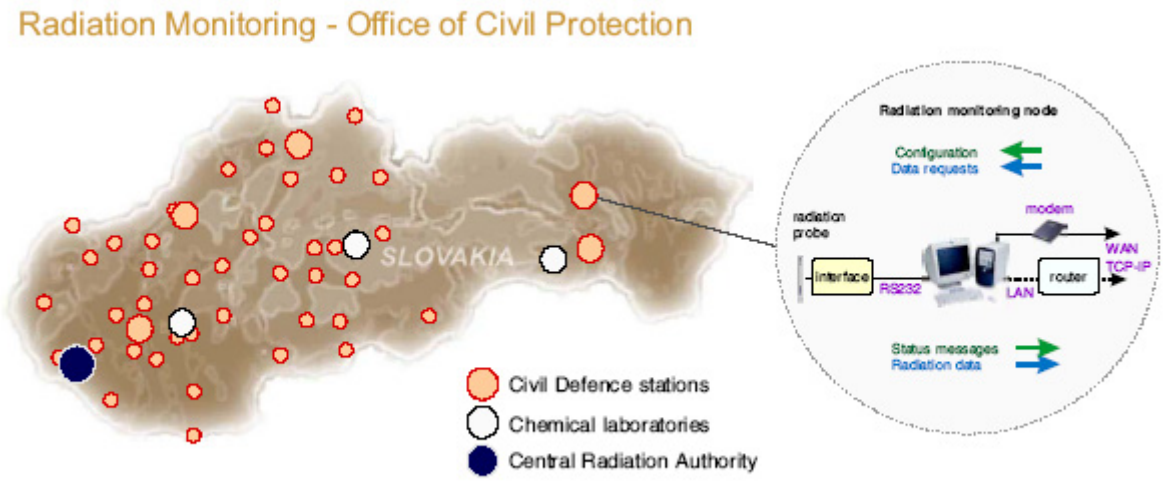
**AUTOMATIC DOSE RATE MONITORING NETWORK – OVERVIEW**

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




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.