EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

KOZLODUY
Nuclear Power Station

National Environmental Radioactivity Monitoring

BULGARIA

26 November to 3 December 2007

Reference: BG-7/07

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES:

- Provisions for monitoring and controlling radioactive discharges and for surveillance of the environment during normal operations of the Kozloduy NPS.
- Provisions for monitoring and controlling levels of radioactivity on the national territory.
- The national radiological early warning network.

DATE: 26 November to 3 December 2007

REFERENCE: BG-7/07

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TABLE OF CONTENTS

Appendix 1	Received documentation
Appendix 2	The verification programme – summary review
Appendix 3	Legislation
Appendix 4	KNPS – radioactive discharges – analytical laboratories
Appendix 5	The KNPS environmental radioactivity monitoring programme

TECHNICAL REPORT

1 ABBREVIATIONS

AISARC	Automatic Information System for Ambient Radiation Control
AISORM	Automatic Information System for On-site Radiation Monitoring
BMI	Bulgarian Metrological Institute
BULRAMO	Bulgarian Radiation Monitoring network
CAM	Continuous Air Monitor
CLVSEE	Central Laboratory for Veterinary and Sanitary Examinations (of the NVMS)
DAMS	Discharge Activity Measurement System
DCT	Discharge Control Tank (for liquid discharges)
DG TREN	Directorate-general Transport and Energy (of the EC)
EC	European Commission
EEA	Environmental Executive Agency (of the MEW)
EP-1	KNPS Units 1 to 4 (shut down units)
EP-2	KNPS Units 5 and 6 (operational)
(N)ERMP	(National) Environmental Radioactivity Monitoring Programme
EU	European Union
HEPA	High-efficiency particulate filter
KNPS	Kozloduy NPS
LIMS	Laboratory Information Management System
LLA	Long-lived aerosols
LRRM	Laboratory for Radioecology and Radioisotope Measurements (of the NCAS)
MAFS	Ministry of Agriculture and Food Supplies
MDCR	Main Dosimetry Control Room
MEE	Ministry of Economy and Energy
MEW	Ministry of Environment and Water
MH	Ministry of Health
MSPDA	Ministry of State Policy for Disasters and Accidents
NCAS	National Centre for Agricultural Science
NCPS	National Civil Protection Service (of the MSPDA)
NCRRP	National Centre for Radiobiology and Radiation Protection (of the MH)
NIMH	National Institute for Meteorology and Hydrology
NPS	Nuclear power station
(B)NRA	(Bulgarian) Nuclear Regulatory Agency
N(R)VMS	National (Regional) Veterinary Medical Service
OJ	Official journal (of the EU)
ORDC	Operational Radiation and Dosimetry Control Section (of the KNPS)
PEML	Public Exposure Monitoring Laboratory (of the NCRRP)
RCD	Radiation Control Department (of the RIPCPH)
RLEW	Regional Laboratories of Environment and Water (of the EEA)
RIPCPH	Regional Inspectorate for the Protection and Control of Public Health (of the MH)

RMD	Radio-ecological Monitoring Department (of KNPS)
RWTF	Radioactive Waste Treatment Facility (on the Kozloduy site)
SFSF	Spent fuel storage facility (on the Kozloduy site)
SOP	Standard operating procedure
WMS	Weather Monitoring System
WWER	Water cooled-water moderated energy reactor (KNPS reactor type)

2 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State establish the 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 (EC) the right of access to such facilities in order that it may verify their operation and efficiency.

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

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

- 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.

From 26 to 30 November 2007, a verification team from DG TREN visited the site of the Kozloduy Nuclear Power Station located on the banks of the Danube River, Vratsa province, north-western Bulgaria. The aim of the verification was to check the operation and efficiency of the facilities and associated analytical laboratories for continuous monitoring of the level of radioactivity in air, water and soil in the vicinity of the Kozloduy site and on the territory of Bulgaria. The verification scope also covered on-site facilities monitoring liquid and aerial discharges of radioactivity into the environment.

During the verification activities addressing the monitoring of radioactive discharges from the Kozloduy NPS, the EC team was accompanied by representatives of the licensing authority, the Bulgarian Nuclear Regulatory Agency. During the verification activities relating to monitoring of the environment in the vicinity of Kozloduy, the EC team was accompanied by representatives of the Nuclear Regulatory Agency, the Ministry of Health, the National Institute for Marine Hydrology, the Ministry of Energy and Economy, and the Ministry of Environment.

The team also visited the central (Sofia) and regional (Vratsa) environmental laboratories of the Ministry of Environment and Water and the Ministry of Health, both ministries having competence and responsibilities in the radiological surveillance of the Kozloduy NPS as well as the radiological surveillance of the national territory.

The visit included meetings with representatives of various national authorities having competence in the field of radiation protection. An opening meeting and a closing meeting were held, with all parties involved during the visit, on the premises of Ministry of Economy and Energy at Sofia.

Finally, part of the verification team extended its stay in Bulgaria to verify the level of implementation of European Union legislation on the control of contamination of foodstuffs in the post-Chernobyl era ([2]). The verification activities were conducted from 30 November to 3 December 2007 and focussed on the procedures put in place at the airport of Sofia and at the maritime port of Varna on the Black Sea. The team was accompanied by representatives of the Ministry of Health, the Ministry of Agriculture and Food Supplies and the Bulgarian Customs Agency.

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

2 Council Regulation 90/737/EEC 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 (OJ L-82 of 29/03/1900).

The present report contains the results of the verification team's review of relevant aspects of discharge control and radiological environmental surveillance on and around the Kozloduy site, as well as elements of the national radiological surveillance put in place by the competent Bulgarian authorities.

3 PREPARATION AND EXECUTION OF THE VERIFICATION

3.1 Preamble

The Commission's decision to request the execution of an Article 35 verification was notified to the Bulgarian Permanent Representation to the European Union by letter TREN.H4 SVdS/lmr D(2007) 306612 dated 28 March 2007.

Subsequently, practical arrangements for the implementation of the verification were made with a delegation of the Bulgarian competent authorities during a meeting held at Luxembourg on 14 June 2007. At this meeting the EC delegation presented the scope and conduct of its verification activities. The Bulgarian competent authorities provided preliminary information on the Bulgarian legislation and its implementation with respect to radiation protection, as well as an overview of the Kozloduy nuclear power station site.

The Bulgarian Ministry of Economy and Energy, in particular its Directorate for the Security of Energy Supply, together with the Bulgarian Permanent Representation to the Union, efficiently acted as co-ordinators and thus ensured not only that the verification programme could be fully implemented, but also that all ministries involved in matters of radiation protection relevant to the mission were present and available during the week.

3.2 Programme of the visit

A preliminary programme of verification activities under the terms of Art.35 of the Euratom Treaty was discussed and agreed upon with the Bulgarian competent authorities.

The programme encompassed:

- The verification of liquid and gaseous radioactive discharge control as carried out by the Kozloduy NPS (sampling and monitoring systems, analytical methods, quality assurance, bookkeeping, reporting).
- The verification of the environmental radioactivity monitoring programmes as implemented by:

  i. The Kozloduy NPS;
  ii. The Ministry of Environment and Water;
  iii. The Ministry of Health.

  and to a lesser extent due to the limited time available, by:

  iv. The Ministry of State Policy for Disasters and Accidents;
  v. The National Institute for Meteorology and Hydrology.

  For the same reasons the programme of the Ministry of Agriculture Food Supply was only addressed in terms of exchange of information; verification activities proper were not conducted.

  At the locations visited the verification addressed technical aspects of monitoring and sampling activities, analytical methods used, quality assurance, data handling, archiving and reporting.

- The verification, at the customs offices at Sofia airport and at the maritime port of Varna, of the level of implementation of EU post-Chernobyl regulations.

The verifications were carried out in accordance with the programme, a summary overview of which is attached asAppendix 1 to this report.

3.3 Documentation

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Bulgarian authorities in response to a questionnaire from the Commission. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 2. The verification team notes the comprehensiveness of the documentation provided.

The information thus provided has been extensively used for drawing up the descriptive sections of the report.

3.4 Representatives of the competent authorities and the operator

During the verification visit, the following representatives of the national authorities and the operator were met:

Ministry of Economy and Energy:

Vasil HADJIEV	Director of the Security of Energy Supply Directorate
Emil GARLOV	Head of the Nuclear Energy and Safety Unit
Katerina KOSTADINOVA	Chief expert of the Nuclear Energy and Safety Unit
Ivan IVANOV	Chief expert of the European Integration in the Energy Sector Unit

Nuclear Regulatory Agency:

Ventsislav MILIOVSKI	Director-general of DG Regulation of the Safety of Nuclear Facilities
Lidia KATSARSKA	Chief inspector of DG Regulation of the Safety of Nuclear Facilities

Ministry of Health:

Dr. Tencho TENEV	Chief State Health Inspector
Ass. Prof. Milena HRISTOVA	Radiation protection consultant
Ass. Prof. Radostina GEORGIEVA	Director of the National Center on Radiobiology and Radiation Protection (NCRRP)
Dipl. Eng. Viktor BADULIN	Deputy-director of the NCRRP
Dipl. Eng. Rositsa KARAIVANOVA	Head of the Public Exposure Measurement Laboratory (at the NCRRP)
Rositza TOTZEVA	Deputy-head of the Public Exposure Measurement Laboratory (at the NCRRP)
Dipl. Eng. Kremena IVANOVA	Head of the Inspectorate for the Control of Nuclear Facilities (at the NCRRP)
Dr. Chavdar MANOV	Director of the Regional Inspection for Protection and Control of Public Health (RIPCPH) - at Vratsa
Dr. Svetoslav SAVCHEV	Head of the Radiation Control Unit of the RIPCPH - at Vratsa
Dr. Emil ANGELOV	Director of RIPCPH - at Varna
Dr. Krasimira LAZAROVA	Head of the Radiation Control Department of the RIPCPH - at Varna

Ministry of Environment and Water:

Dimitar VERGIEV	Executive Director of the Environmental Executive Agency (EEA)
Krasimira AVRAMOVA	Director of the Environment Monitoring Directorate of the EEA
Yoana HRISTOVA	Head of the International Activities Unit; Environmental Monitoring Directorate of the EEA
Hristina HALACHLIYSKA	Head of the Ionizing Radiation Section; Environmental Monitoring Directorate of the EEA
Mihail SHISHENKOV	Head of the Radiological Measurements Laboratory; Analytical Laboratories Directorate of the EEA
Kosyo VOYCHEV	Chief expert of the Ionizing Radiation Section; Environmental Monitoring Directorate of the EEA
Rumyana MITKOVA	Head of the Regional Laboratory of Environment and Water (RLEW) EEA at Vratsa
Milka KATRANKIEVA	Chief expert of the Radiological Measurements Laboratory; RLEW EEA at Vratsa

Ministry of Agriculture and Food Supply:

Dr. Yordanka HRISTOZOVA	Director of the Security of Information and Defense and Mobilization Preparedness Directorate
Dipl. Eng. Stoil STOEV	Head of the Defense and Mobilization Preparedness Unit
Dr. Milena DJOREVA	National Center for Agricultural Science (NCAS)
Dr. Lidia MISHEVA	Executive Head of the Radioecology and Radioisotope Research Laboratory of the Institute of Pedology 'N. Pushkarov' (NCAS)
Dr. Yordan KIROV	Head of the Regional Veterinary Medical Service (RVMS) - at Varna
Dr. Elena SLAVOVA	Head of the Testing Laboratory; RVMS at Varna
Dr. Kiril KIROV	Director-general of the Central Laboratory for Veterinary and Sanitary Examinations and Ecology (CLVSEE) of the NVMS

Ministry of State Policy for Disasters and Accidents:

Dipl. Eng. Ivan ZAZDROV	Head of the Crisis Management Unit of the Directorate-general "National Civil Protection Service" (NCPS)
Lyudmila SIMEONOVA	Chief inspector of the Radiation and Chemical Protection Section of the NCPS
Dipl. Eng. Nikolay PENCHEV	Director of the Civil Protection Directorate of the Montana region
Dipl. Eng. Pavel YANCHIK	Chief inspector of the Radiation and Chemical Protection Section - at Vratsa

Kozloduy NPS:

Mitko YANKOV	Director of the Safety and Quality Directorate
Radelina TRANTEEVA	Head of the Safety Office
Stoyan KALCHEV	Chief engineer of EP-1 (Units 1 to 4)
Dimitar ANGELOV	Chief engineer of EP-2 (Units 5 & 6)
Georgi VALCHEV	Chief expert - radiation protection
Valentina STANCHEVA	Chief inspector - radiation protection
Rusiyan TSIBRANSKI	Head of the Radioecological Monitoring Department
Valentin AVRAMOV	Head of the Radioactivity Measurement Laboratory
Nikolay DIMITROV	Head of the General Radiation and Dose Control Section of EP-1

Galina NESHOVSKA	Head of the Radiochemistry Section of EP-1
Biserka PANTALEEVA	Head of WCH and PHCHC section - EP-1
Plamen KOTLAROV	Head of section Reactor Operation of EP-1
Georgi SLAVCHEV	Head of General Radiation and Dose Control Section of EP-2
Nikolay GERCHEV	Head of the Radiochemistry Section of EP-2
Daniela ATANASOVA	Technologist, ORDC section, EP-2
Nikolay NIKOLOV	Head of the Radiation Technology Control Group of EP-2
Plamen MISHEV	Technologist, ORDC section, EP-2
Georgi PETKOV	Head of section Reactor Operation of EP-2
Mariela IVANOVA	Technologist, PHCHC section, EP-2
Marieta SHEKEROVA	Head of Quick measurement laboratory, PHCHC section, EP-2
Valentin STANCHEV	Head of the Spent Fuel Storage Facility
Marianna MANOEVA	Head of ISC section, Spent Fuel Storage Facility

Bulgarian Customs Agency:

Angelina ANGELOVA	Director of Tariff Policy Directorate
Ivo KONDOV	Chief expert, Tariff Policy Directorate
Emil DOYCHINOV	Head of Regional Customs Office - Sofia Airport
Sonia ANGELOVA	Head of Regional Customs Office - Varna

National Institute for Meteorology and Hydrology:

Hristomir BRANZOV	Director of the Composition of the Atmosphere and Hydrosphere Department
Blagorodka VELEVA	Head of the Analysis and Measurements Laboratory

4 LEGISLATION AND COMPETENT AUTHORITIES

4.1 Primary legislation

The basic act regulating the use of nuclear energy and ionizing radiation is the Act on the Safe Use of Nuclear Energy (hereafter: the Act), published in the State Gazette nr 63 of 28 June 2002.

Article 4 of the Act lays down that "State regulation of the safe use of nuclear energy and ionising radiation, the safety of radioactive waste management and the safety of spent fuel management is implemented by the Chairman of the Nuclear Regulatory Agency (NRA), […]". The Chairman is an independent and specialised authority of the executive power and is vested with competencies, as specified in this Act".

Article13 of the Act defines which Ministers exercise specialised radiation protection control functions, in accordance with their competencies as specified by other laws.

4.2 Derived legislation

Derived legislation that needs mentioning in the framework of this report is:

- Regulation on the procedure for issuing licenses and permits for the safe use of nuclear energy (State Gazette Nr 41 of 18 May 2004; as amended in State Gazette Nr 78 of 30 September 2005). This regulation governs all matters related to licensing as demanded by the Act.
- Regulation on basic norms of radiation protection (State Gazette Nr 73 of 20 August 2004). This regulation transposes Council Directive 96/29/Euratom as well as Council Directives 97/43/Euratom ([3]) and 90/641/Euratom ([4]) into national law.
- Regulation of the conditions and procedure for establishing of special statutory areas around nuclear facilities and facilities with sources of ionising radiation (State Gazette Nr 69 of 6 August 2004). This regulation governs the radiological surveillance zones around nuclear facilities as demanded by the Act: size and boundaries of zones, responsibilities of actors, provisions for the radiological monitoring of the population and the environment.
- Regulation on radiation protection during activities with sources of ionising radiation (State Gazette Nr 74 of 24 August 2004). This regulation puts in place requirements for radiation monitoring during activities with sources of ionizing radiation. It specifies the technical and organizational rules necessary to abide by the national basic norms for radiation protection.

An extensive list of the legal provisions having a bearing on radiation protection matters is given in Appendix 3.

4.3 Competent authorities

Authorities having competence under Art.35 of the Euratom Treaty in Bulgaria are:

- The Ministry of Economy and Energy (MEE),
- The Nuclear Regulatory Agency (NRA),
- The Ministry of Environment and Water (MEW),
- The Ministry of Agriculture and Food Supplies (MAFS),
- The Ministry of Health (MH),
- The Ministry of State Policy for Disasters and Accidents (MSPDA),
- The National Institute for Meteorology and Hydrology (NIMH).

Note: Hereafter the acronym ERMP stands for Environmental Radioactivity Monitoring Programme.

4.3.1 Ministry of Economy and Energy

Nuclear facilities in Bulgaria are state-owned. The MEE is the sponsoring authority and principal owner of the Kozloduy nuclear power station (KNPS) as well as of radioactive waste management facilities, including the Spent Fuel Storage Facility (SFSF) at Kozloduy. On the KNPS site the State Enterprise for Radioactive Waste operates the solid waste management facilities: the processing and conditioning operations were taken over from KNPS management in the year 2005 and operate under a separate license.

The following competencies of the MEE are pertinent to this report:

- safety programs and reliability improvement of nuclear facilities;
- decommissioning of nuclear facilities;
- implementation of the national strategy for the management of spent fuel and radioactive waste;
- control over the investment projects for the modernisation of KNPS Units 5 and 6.

[3] Council Directive of 30 June 1997 on health protection of individuals against the dangers of ionising radiation in relation to medical exposure (OJ L-180 of 09/07/97 page 22).

[4] Council Directive of 4 December 1990 on the operational protection of outside workers exposed to the risk of ionising radiations during their activities in controlled areas (OJ L-349 of 13/12/90 page 21).

4.3.2 Nuclear Regulatory Agency

The NRA regulates the safe use of nuclear energy and sources of ionising radiation as well as the safe management of radioactive waste and spent fuel.

The functions of the NRA are, *inter alia*:

- licensing of nuclear facilities and practices involving sources of ionising radiation;
- regulatory control (inspections) and enforcement measures regarding compliance with nuclear safety and radiation protection legislation;
- provision and maintenance of expertise in the field of nuclear safety and radiation protection;
- drafting of legislative or regulatory requirements and subsequent submission thereof to the Council of Ministers for approval;
- conducting a part of the emergency response in the occurrence of a nuclear or radiation accident.

During the licensing process the NRA assesses the following radiation protection related dossiers that must be presented by the applicant:

- the radiological surveillance programme around the nuclear power plant site;
- a comprehensive quality controlled radiation protection manual;
- for each reactor justified gaseous and liquid activity discharge limits.

The above documents, once approved by the NRA, cannot be modified without the explicit consent of the NRA. The licensee has a statutory obligation to regularly report on the data resulting from the implementation of the radiation protection programmes.

4.3.3 Ministry of Environment and Water

The Ministry of Environment and Water (MEW) is the principal actor responsible for monitoring the state of the environment on the national territory.

The Executive Environment Agency (EEA) and the Regional Laboratories for the Environment and Waters (RLEW) are entrusted with the operational responsibility for monitoring environmental radioactivity on behalf of MEW. In total there are fifteen RLEWs, seven of which carry out radiological monitoring (Burgas, Varna, Vratsa, Montana, Pleven, Plovdiv, and Stara Zagora).

The EEA has two relevant directorates: the "Environmental Monitoring Directorate" (EMD) and the "Laboratory and Analytical Activities Directorate" (LAAD).

The EMD operates the automated online national gamma doserate monitoring and early warning network comprising 26 measurement stations known as BULRAMO (Bulgarian Radiation Monitoring network). The continuous measurements from the BULRAMO network are available, online in real time to concerned national authorities and the Kozloduy NPS. They are also downloaded once a day to the European Commission public EURDEP internet site.

The LAAD coordinates a laboratory-based national environmental monitoring system consisting of 8 laboratories (the central laboratory at Sofia and the 7 Regional laboratories as mentioned above). The LAAD environmental radioactivity monitoring programme is developed within the EEA and approved by the MEW. The results of laboratory measurements (reported on a quarterly basis) are centralised in a database run by the EEA's Ionising and Non-ionising Radiation Section. Chiefly, the monitored media are:

- radionuclides in the atmosphere;
- natural and anthropogenic radionuclides in soils, sediments, wastes;
- total alpha- and beta- activity of surface, ground and waste waters;
- Cs-137 and H-3 activity of surface, ground and waste waters;
- radon at (uranium) mining sites.

The MEW is, in conjunction with the Ministry of Health, responsible for the implementation of Commission Recommendation 2000/473/Euratom on the application of Article 36 of the Euratom Treaty ([5]).

4.3.4 Ministry of Health

The state policy for public health protection is carried out by the MH. The MH discharges its operational responsibilities in radiation protection through the:

- National Centre for Radiobiology and Radiation Protection (NCRRP), more in particular through its Public Exposure Monitoring Laboratory and its Inspectorate for the Control of Nuclear Facilities;
- Regional Inspectorates for the Protection and Control of Public Health (RIPCPH), in particular the Radiation Control Departments (RCD) in 5 out of 28 RIPCPHs (at Burgas, Plovdiv, Ruse, Varna and Vratsa).

The Public Exposure Monitoring Laboratory (PEML) of the NCRRP, located at Sofia, is in charge of:

- the radiological site-related ERMP around the KNPS;
- the radiological surveillance around former uranium mining and milling sites;
- the radiological monitoring of foodstuffs and drinking water in the Sofia region;
- the assessment of public exposure resulting from the use of ionising radiation sources (operation of the KNPS and other nuclear sites, the medical sector and industry);
- the operation of a single gamma dose rate monitoring station in Sofia.

Furthermore the PEML, as reference lab, is in charge of performing quality assurance assistance and controls in the 5 regional inspectorates that operate a RCD (and hence perform radiological assays and measurements).

The 5 regional inspectorates with a RCD are in charge of:

- their respective regional ERMPs;
- regional control of all practices involving sources of ionising radiation.

Both the NCRRP and the RIPCPH are part of the national radiological emergency response structure.

The MH is, in conjunction with the Ministry of Environment and Water, responsible for the implementation of Commission Recommendation 2000/473/Euratom on the application of Article 36 of the Euratom Treaty.

Note: both the MH and MAFS share responsibilities in the implementation of Council Regulation 90/737/EEC and associated EU legislation governing the import of agricultural products from third countries into the Community (see section 9 of this report).

4.3.5 Ministry of Agriculture and Food Supplies

On behalf of the MAFS, two ISO/IEC 17025 accredited laboratories are carrying out distinct ERMPs:

- for samples of <u>animal</u> origin: the Central Laboratory for Veterinary and Sanitary Examinations (CLVSEE) of the National Veterinary Medical Service;
- for samples on <u>non-animal</u> origin: the Laboratory for Radioecology and Radioisotope Measurements (LRRM) of the Institute for Pedology at the National Centre for Agricultural Science.

Note: as under 4.3.4 above.

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[5] Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole (OJ L-191 of 27.07.2000)

4.3.6 Ministry of State Policy for Disasters and Accidents

The National Civil Protection Service (NCPS) coordinates a network of 335 municipal and 28 county radiation surveillance posts throughout Bulgaria. The posts are staffed by personnel from county and municipal administrations. In addition, there are a further five radiation surveillance posts within the Kozloduy 30 km zone. Manual doserate measurements are performed three times a day; the average result thereof is transmitted daily to the NCPS central office in Sofia.

The NCPS operates and maintains one BULRAMO station that is situated on the premises of the NCPS Emergency Centre at Sofia. The Emergency Centre is linked to the central BULRAMO server at the MEW and acts as back-up in case of need.

The NCPS also runs a laboratory-based radiological surveillance programme: environmental samples are assessed at the Central Laboratory Complex in Sofia.

Furthermore the NCPS participates in inspections carried out by the NRA at the KNPS and other facilities where sources of ionising radiation are used. The activities of the NCPS inspectors focus on (radiological) risk assessments as well as verification of emergency planning arrangements in case of accidents.

Finally, the officers on duty at the Municipality Security Councils, carry out dose rate measurements three times a day. The average result thereof is transmitted daily to the NCPS central office.

4.3.7 National Institute for Meteorology and Hydrology

In terms of radiological surveillance the activities of the NIMH include:

- the assessment of airborne radioactivity through the operation of a network of air samplers (sampling and subsequent laboratory analysis);
- the assessment of radioactivity in wet and dry depositions (precipitation and fallout), surface waters and city water conduits (sampling and subsequent laboratory analysis);
- the assessment of ambient gamma dose rate through the operation of a monitoring network.

The results are loaded to the web site of NIMH.

5 CONTROL OF RADIOACTIVE DISCHARGES

5.1 General description of the Kozloduy NPS

The site of the Kozloduy NPS (KNPS) is located 3.5 km south-east of the town of Kozloduy and 12 km north-west of Miziya town, in the region of Vratsa (north-west of Bulgaria).

The border with the Republic of Romania (the Danube River) is situated approximately 3 km north of the site.

KNPS consists of six units, which were constructed and put in operation in three stages:

- Stage 1, from 1970 to 1975: units 1 and 2 (reactor type WWER 440)
- Stage 2, from 1973 to 1982: units 3 and 4 (reactor type WWER 440/B230)
- Stage 3, from 1982 to 1991: units 5 and 6 (reactor type WWER 1000/B320)

The operational status of the units is as follows:

	Connection to the grid	Final shutdown
Unit 1	14.07.1974	31.12.2002

Unit 2	24.08.1975	31.12.2002
Unit 3	16.12.1980	31.12.2006
Unit 4	17.05.1982	31.12.2006
Unit 5	29.11.1987	-----
Unit 6	02.08.1991	-----

The units that were shutdown have operational status E that corresponds to the reactors have been defuelled and all fuel is stored in the reactor spent fuel ponds. No decommissioning or dismantling activities have been undertaken since the final shutdown dates.

The KNPS site also houses a temporary Spent Fuel Storage Facility (SFSF) and a Radioactive Waste Treatment Facility (the latter operated by the State Enterprise for Radioactive Waste).

The main features and parameters of the operational WWER 1000 units are:

Reactor Thermal capacity Electrical capacity Primary circuit pressure Reactor inlet coolant temperature Reactor outlet coolant temperature Fuel assemblies Reactor control rod assemblies Fuel rods in a fuel assembly Average density of the thermal flow Average linear thermal flow Loops in primary circuit Coolant flow rate Maximum fuel enrichment in U-235	 3000 MW 1000 MW 15.7 MPa 289 °C 320 °C 163 61 312 57.9 W/cm² 165.7 W/cm 4 84800 m³/h 4.4 %
Steam Generators Type Number per unit Steam capacity Thermal power Steam pressure Feed water temperature	 PGV-1000 4 1480 t/h 2.690 E+09 kJ/h 6.3 MPa 220 °C
Turbines Type Number per unit Power Main steam parameters - Pressure - Temperature	 K-1000-60 1 1000 MW 5.9 MPa 274 °C
Main Coolant Pumps Type Number per unit	 GCN-195M 4
Generators Type Rated Power Generator voltage Grid voltage	 TVV-1000-4 1000 MW 24 kV 400 kV

5.2 Limits for gaseous and liquid releases

Bulgarian law stipulates that the limits for gaseous and liquid releases from the KNPS, for all operational conditions of the units, have to comply with an annual effective dose limit to a member of the population that is less than 0.25 mSv: 0.2 mSv from discharges of gaseous activity and 0.05 mSv from discharges of liquid activity. These dose limitations are transcribed in activity discharge limitations (see tables below).

In addition, quarterly and annual discharge control levels are defined: these levels, when breached, oblige the operator to investigate and report to the licensing authority. Wherever appropriate, remedial action is undertaken after approval by the authority (the NRA).

5.2.1 Limits for liquid releases

Two streams of liquid effluents from KNPS are subject to limitations.

- Waste process water arising from operations:
  - Their volumetric activity is controlled before and during discharge into the environment.
  - The discharged activity is measured for accountancy purposes.
- Sanitary waste waters (that are potentially contaminated); their volumetric activity is controlled during their discharge into the environment.

KNPS site limits and control levels for total activity and tritium in waste process water:

	Quarterly control level	Quarterly limit	Annual control level	Annual limit
Total activity excl. H-3 (GBq)	37	185	148	740
Tritium (GBq)	6475	46250	25900	185000

The site limits are shared out between:

- Power Production-1, (or EP-1, consisting of shutdown units 1 to 4) and
- Power Production-2, (or EP-2, consisting of operational units 5 and 6).

EP-1	Quarterly control level	Quarterly limit	Annual control level	Annual limit
Total activity excl. H-3 (GBq)	22.2 (60%)	111 (60%)	88.8 (60%)	444 (60%)
Tritium (GBq)	2590 (40%)	18500 (40%)	10360 (40%)	74000 (40%)

EP-2	Quarterly control level	Quarterly limit	Annual control level	Annual limit
Total activity excl. H-3 (GBq)	14.8 (40%)	74 (40%)	59.2 (40%)	269 (40%)
Tritium (GBq)	3885 (60%)	27750 (60%)	15540 (60%)	111000 (60%)

The limit for volumetric activity of operational waste water is set at 1850 Bq/l (excluding Tritium) and the corresponding control level at 370 Bq/l. These limits apply to any batch of operational waste water, before and during its discharge into the environment.

For (potentially contaminated) sanitary waste waters the volumetric activity limit is set to 11 Bq/l.

5.2.2 Limits for gaseous releases

Daily limits:

	Limit (GBq)	Control level (GBq)
Noble gas	7.0 E+04	7.0 E+03
I-131	1.4	0.14
Radionuclides with a half-life > 24 H (LLA - long-lived aerosols)	2.0	0.2

Monthly limits:

	Limit (GBq)	Control level (GBq)
Cr-51	2.09	0.2
Mn-54	2.09	0.2
Co-60	2.09	0.2
Sr-90	0.209	0.02
Sr-89	2.09	0.2
Cs-137	2.09	0.2

Note: any other radionuclides detected in aerosols must be reported.

Yearly limits (based on the daily limits):

	Limit
Noble gas	2.555 E+04 TBq
I-131	5.11 E+02 GBq
LLA	7.3 E+02 GBq

5.2.3 New gaseous discharge authorisations

At the end of 2006 KNPS filed a proposal with the competent authority (the NRA) to modify the site limitations for gaseous releases, also introducing annual limits and control levels for Tritium and Carbon-14. The proposed annual limits were derived from an effective dose of 50µSv/year for any member of the population. Based on operational experience the limitations are apportioned between the various ventilation stacks (abbreviated as VS) on the site.

Proposed yearly discharge limits (note: AB = auxiliaries building):

	VS-1 Units 1+2 AB-1	**VS-2** Units 3+4 AB-2	**VS-5** Unit 5	**VS-6** Unit 6	**VS-3** AB-3 (Units 5 + 6)	**VS-4** SFSF	KNPS Site Limit
Noble gas (TBq)	100	100	1400	1400	700	---	5600
I-131 (GBq)	3	3	13,5	13,5	5	---	65
LLA (GBq)	3	3	12	12	5	3	50
H-3 (TBq)	10	10	60	60	60	---	250
C-14 (GBq)	1000	1000	9000	9000	9000	---	38000

Proposed daily control levels:

	VS-1	VS-2	VS-5	VS-6	VS-3	VS-4	KNPS site limit
Noble gas (TBq)	0.4	0.4	3.8	3.8	2		15
I-131 (MBq)	8	8	38	38	14		178
LLA (MBq)	8	8	33	33	14	7	137
H-3 (GBq)	26	26	165	165	165		685
C-14 (GBq)	2.7	2.7	24.6	24.6	24.6		104

The NRA granted new licences (confirming the proposed limitations) for:

- VS-1 on 29/11/2007 (reference Nr I-3322 for Unit 1 and reference Nr II-3323 for Unit 2).
- VS-2 on 29/11/2007 (reference Nr III-3324 for Unit 3 and reference Nr IV-3323 for Unit 4).
- VS-4 (SFSF) on 29/11/2007 (reference Nr O-3321).
- VS-5 on 09/08/2007 (reference Nr V-3307).
- VS-6 on 24/10/2007 (reference Nr VI-3319).

5.2.4 General aspects of monitoring of radioactive effluents from KNPS

KNPS organisational entities sharing responsibilities in the monitoring of radioactive discharges:

- Directorate "Safety and Quality":
  - -- Department Nuclear Safety (NS) and Radiation Protection (RP)
  - -- Department Radioecological Monitoring (RM)
- Directorate "Electricity Production"
  - -- Section Operational Radiation and Dosimetry Control (ORDC) - EP-1
  - -- Section Radiochemistry (RCH) - EP-1
  - -- Section Water Chemistry (WCH) and Physical Chemistry Control (PHCHC) - EP-1
  - -- Section Operational Radiation and Dosimetry Control (ORDC) - EP-2
  - -- Section Radiochemistry (RCH) - EP-2
  - -- Section Physical Chemistry Control (PHCHC) - EP-2
  - -- Section Engineering Support and Control (ESC) - Spent Fuel Storage Facility

The monitoring operations are carried out in compliance with the operating licences (one for each unit and one for the spent fuel storage facility), approved technical specifications and KNPS internal standard operating procedures (SOP).

Continuous, online operational monitoring is in place for gaseous discharges (noble gas, I-131 and LLA) and for liquid effluents during the discharge operations proper. The continuous monitoring measures volumetric activity and automatically raises alarms when pre-set thresholds are exceeded (warning and alarm levels). In case of alarm on the liquid discharge line the discharge is manually interrupted.

Sampling of the effluent streams and subsequent laboratory analysis of the samples taken is conducted in order to confirm the results of the operational monitoring and to assess individual radionuclides. Discharge accountancy is based on the laboratory data.

Both operational and periodical monitoring is fully documented in the quality controlled document "Programmes for Radiation Monitoring of the gaseous and liquid effluents during normal operation". Such documents exist for EP-1, EP-2 as well as for SFSF; and contain information on *inter alia*:

- responsibilities (chain of custody);
- sampling locations;
- sampling procedure and frequency thereof;

- technical specifications of the monitoring/sampling devices;
- pre-treatment of samples (where appropriate);
- measurement instructions;
- metrological controls and measurement uncertainties;
- documentation and record keeping of the results;
- reporting of results.

5.3 Monitoring and sampling provisions for gaseous releases – Units 1-4 (EP-1)

5.3.1 Ventilation stacks

Gaseous effluents are discharged through two ventilation stacks (VS):

- VS-1 for units 1+2 and AB-1 "block 1"
- VS-2 for units 3+4 and AB-2 "block 2"

For each block the various ventilation/extraction systems join into one central duct. Before joining the central duct the extraction systems are fitted with HEPA and/or charcoal filter banks (depending on the origin of the extract and thus the potential presence of radioactive contaminants).

This central duct is horizontal and connects to a stack that discharges at a height of 150 m. The duct houses the discharge sampling line nozzles (3 in number) and flow meters. The sampling lines continuously feed (20 l/min) the statutory monitoring and sampling equipment that is installed in a dedicated room.

5.3.2 Monitoring

Continuous on-line monitoring falls under the responsibility of the ORDC, the Operational Radiation and Dosimetry Control section of the KNPS.

For each block the device installed is a RKS2-03 “Kalina” of Russian manufacture.

Kalina measures LLA, I-131 and noble gases. Aerosols and iodine are deposited on appropriate filter bands advances once every 24h. In order to eliminate the short lived nuclides from the measurement result, the acquisition time of 144 minutes starts 21.6 hours after the advance of the band. Noble gases are measured continuously in a 8 dm^3 sampling chamber.

Integrated pulses corresponding to the activity released over 24 hours are registered on electro-mechanical paper loggers, one for each channel of the system. Activity calculations are performed manually every 24 hours in accordance with the related SOP.

Functionality control is implemented through a continuous registration of the pressure differential over the filters: the information is relayed into the Main Dosimetry Control Room (MDCR).

Kalina systems are verified by the Bulgarian Metrological Institute on a yearly basis. The verification activities consist of: maintenance, calibration verification, recalibration if necessary, issuing a verification certificate and to apply validation stickers/tags to the verified piece of equipment.

Kalina main technical features are:

Channel	Detector	Range (Bq/m³)	Total activity (Bq)	Sampling	Acquisition
LLA	Plastic scintillator	1 - 1 E+04	32 - 3.2 E+05	24 hours	144 minutes
I-131	NaI(Tl)	10 - 1 E+04	3.2 - 3.2 E+05	24 hours	144 minutes
Noble gas	Plastic scintillator	1 E+06 - 1 E+10	3.2 E+07 - 3.2 E+11	continuous	continuous

5.3.3 Sampling

A sampling line, in parallel to the line for Kalina, feeds a sampling device for aerosols and then a sampling device for iodines. The filters of both sampling devices are exchanged every day and forwarded to the laboratories for measurement.

The responsibility for periodical monitoring (laboratory analysis) is distributed between three actors: the ORDC section (daily filter replacements and total beta counting), the RCH Section (weekly gamma spectrometry) and the RM Department (quarterly strontium assay and alpha spectrometry).

The analytical methods are:

Sample type	Analytical method	Sample preparation	Time (s)
Aerosol filters, ∅ 52 mm	Total beta activity	Daily direct measurement of single filter	1 E+03
	Gamma spectrometry	Composite weekly sample, Direct measurement	1 E+04
	Gamma spectrometry	Composite monthly sample, Direct measurement	6 E+04
	Beta counting for Strontium	Ashing, radiochemical separation of composite quarterly sample.	6 E+03
	Alpha spectrometry	Ashing, radiochemical separation of composite quarterly sample.	6 E+05
Iodine filters 10 cm^2	Total beta activity	Daily direct measurement of single filter	6 E+04
	Gamma spectrometry	Composite weekly sample, Direct measurement	1 E+04

The detection limits achieved in the year 2007, for the acquisition times given in the table above, have been below the values given hereafter (in Bq/m^3):

Cs-137	Co-60	I-131	Sr-90	Pu-239+Pu-240	Am-241 / Cm-242+Cm-244
2 E-04	3 E-04	2 E-03	1.5 E-05	2 E-08	1 E-07

5.4 Monitoring and sampling provisions for gaseous releases – Units 5-6 (EP-2)

5.4.1 Ventilation stacks

Gaseous effluents are discharged via 3 ventilation stacks (height of 150 m), one per Unit and one for the common Auxiliary Building (AB).

The stacks of the Units consist of an internal and an external ventilation duct (concentric stack-in-stack chimney type). These coaxial stacks are operated in two different modes depending on the status of the unit:

- Units in operation: discharge via VS-i (internal stack).
- During outages: discharge of releases from the containment via VS-e (external stack); from all other zones via VS-i.

The stack on the AB, stack VS-3 (single lumen), also discharges gaseous effluents from the Radioactive Waste Treatment Facility (RWTF) operated by the State Enterprise for Radioactive Waste.

Average flow rates in function of the operating mode:

Stack	Nominal (m^3/h) during power production	Outage (m^3/h)
VS-i (internal stack)	70 000	70 000
VS-e (external stack)	not in operation	70 000
AB-3 stack (VS-3)	300 000	

Sampling of the ventilation stack flows of units 5 and 6 and AB-3 is performed in two stages:

- Primary high-volume sampling within the lumen of the stacks through isokinetic sampling nozzles. A frequency controlled pump ensures the aspiration of the effluent. The pumping frequency is steered by an electronic device that is linked to two airflow probes inside the stack's ventilation duct and to one flow meter on the sampling line. The measurement results of these probes are used to continuously ensure an isokinetic and proportional sampling of the effluent stream.
- Secondary sampling of the primary line. Four secondary sample lines tap into the primary sampling line through dedicated sampling nozzles aspiring with a mean flow rate of 20 l/min. Of the four secondary sampling lines, two lines are feeding on-line monitors: a Kalina RKS2-03 and a DAMS system (Discharges Activity Measurement System) whilst the others lines feed the sampling devices (aerosol and iodine filters). A line for spot-sampling of noble gas is also present.

5.4.2 Monitoring

Continuous on-line monitoring falls under the responsibility of the ORDC, the Operational Radiation and Dosimetry Control section of the KNPS. All DAMS monitoring systems relay their monitoring data and operational status into the MDCR where these are displayed in real time.

- **Kalina RKS2-03**

Six Kalina systems (described in section 5.3.2 above) are in place: one on the AB stack, one on each external stack of Units 5 and 6, one on the internal stack of Unit 5 and two on the internal stack of Unit 6. The Kalina systems act as back-up to the DAMS monitoring devices.

- **DAMS**

Since the year 2006, in the framework of a modernisation programme, the monitoring capability at the stacks was upgraded with Discharge Activity Measurement Systems (DAMS) supplied by Westinghouse.

DAMS consists of:

- A measurement system for normal operating conditions: 5 monitors of type CAM 300 PIG FF, one system per ventilation stack (Unit 5, Unit 6, AB).
- A measurement system for emergency conditions: 2 monitors of type CAM 300 GA; one system for each internal VS-2 stack (Unit 5, Unit 6).
- Associated computer systems for storage and display of acquired data.

The secondary sampling line feeding DAMS is heated to prevent any condensation within the systems and is temperature and pressure corrected. The flow through the system is proportional to the flow within the primary sampling line.

The DAMS systems are verified by the Bulgarian Metrological Institute on a yearly basis. The verification activities consist of: maintenance, calibration verification, recalibration if necessary, issuing a verification certificate and to apply validation stickers/tags to the verified piece of equipment.

DAMS for normal operating conditions

The CAM 300 PIG FF system provides for real time activity concentration measurements of aerosols (single channel), Iodine-131 (single channel) and Noble gas (double channel). After every 24h period the system calculates the total daily discharges. Every channel has its own sampling device, detector and associated electronics. Detectors are shielded and backgrounds are automatically subtracted.

The aerosol and iodine channels are equipped with fixed filters, glass fibre filter and charcoal filter respectively. The noble gas channel is equipped with 2 serial measurement chambers (3 dm³ each).

Aerosol channel	
Detector type	Beta-scintillator
Measurement range (Bq/m³)	1 – 3.7 E+05
Data transfer	Refresh rate 1 min. Averaging time 60 min.
Measured radionuclides	LLA and SLA

I-131 channel	
Detector type	Gamma-scintillator
Measurement range, (Bq/m³)	4.7 – 1.9 E+05
Data transfer	Refresh rate 1 min. Averaging time 60 min.

Noble gas channels		
Parameter	Beta channel	Gamma channel
Detector type	Beta-scintillator	Gamma-scintillator
Energy range	150 – 2500 keV	70 – 400 keV
Measurement range (Bq/m³)	5 E+04 – 2 E+10 (Xe-133)	5 E+04 – 2 E+10 (Xe-133)
Measured radionuclide	Total beta	Xe-133 and Xe-135
Data transfer	Refresh rate 1 min. Averaging time 10 min.	

DAMS for emergency conditions

The CAM 300 GA wide range monitors have three measurement channels equipped with GM counters: two parallel channels (redundancy) that both measure aerosols and I-131 and one channel for the determination of noble gas (all with a detection range between 3.6 E+06 and 3.6 E+16 Bq/m³). The systems provide real-time activity concentration measurements as well as the total activity released over every 24 hours.

5.4.3 Sampling

The responsibility for periodical monitoring (laboratory analysis) is distributed between two actors: the ORDC section (filter replacements, total beta counting, and gamma spectrometry) and the RM Department (quarterly strontium assay and alpha spectrometry).

The DAMS aerosol filters, iodine cartridges and noble gas samples (the latter in a Marinelli geometry) are exchanged respectively taken every 10 days.

A sampling line, in parallel to the line for Kalina, feeds a sampling device for aerosols and then a sampling device for iodines. The filters of both sampling devices are exchanged every day and forwarded to the laboratories for measurement.

Sample type	Analytical method	Sample preparation	Acquisition
DAMS			
Aerosol filter	Gamma spectrometry	Direct measurement	3600 sec
Noble gas sample	Gamma spectrometry	Direct measurement	1800 sec (short-lived) 16 hours (others)
Iodine cartridge	Gamma spectrometry	Direct measurement	3600 sec
Parallel sampling device			
Aerosol filter	Total beta activity	Daily direct measurement	300 sec
	Alpha spectrometry	Ashing, radiochemical separation of composite quarterly sample.	6 E+05 sec
	Beta counting for Strontium	Ashing, radiochemical separation of composite quarterly sample.	6 E+03 sec
Iodine filter	Total beta activity	Daily direct measurement	300 sec

The detection limits achieved in the year 2007, for the acquisition times given in the table above, have been below the values given hereafter (in Bq/m³):

Cs-137	Co-60	I-131	Sr-90	Pu-239+Pu-240	Am-241 / Cm-242+Cm-244
1.5 E-03	2 E-03	3 E-03	4 E-05	1 E-07	1 E-07

5.5 Monitoring and sampling provisions for gaseous releases – SFSF

5.5.1 Monitoring

Under normal operating conditions the Spent Fuel Storage Facility (SFSF) only discharges aerosols. Continuous on-line (operational) monitoring is performed with a Kalina RKS2-03 system for aerosols.

For emergency conditions an alpha/beta aerosol monitor type ABPM-201L and a noble gas monitor type NGM-204L (both manufactured by MGP Instruments) have been installed.

The main features of the ABPM-201L monitor are:

-	detector	Silicon	2 x 450 mm² PIPS: background + sample
-	filter type	FSLW	ribbon filter - up to 6 months of autonomy
-	measurement range	alpha	1 E-02 to 1 E+04 Bq/m³
		beta	1 to 1 E+07 Bq/m³
-	energy range	alpha	4.2 to 5.5 MeV
		beta	80 keV to 2 MeV
		gamma	80 keV to 2 MeV
-	control levels	warning	5 Bq/m³
		alarm	40 Bq/m³

The main features of the NGM 204-L monitor are:

-	detector	Silicon	2 x 450 mm² PIPS: background + sample
-	sample geometry	cylindrical	300 cm³
-	measurement range	beta	3.7 E+04 to 1 E+10 Bq/m³
-	energy range	beta	80 keV to 2.5 MeV
-	control levels	warning	1.5 E+05 Bq/m³
		alarm	1.5 E+06 Bq/m³

Both the ABPM and NGM systems measure over 10 second periods (Bq/m^3), the results of which are kept in memory in order to calculate the total activity released (Bq/24hours). All acquired and computed data are stored in a database and are displayed in real time on a workstation in the OCR.

The systems are verified by the Bulgarian Metrological Institute on a yearly basis. The verification activities consist of: maintenance, calibration verification, recalibration if necessary, issuing a verification certificate and to apply validation stickers/tags to the verified piece of equipment.

5.5.2 Sampling

A sampling line, parallel to the Kalina line, feeds an aerosol filter that is exchanged monthly for analysis in the laboratory (discharge accountancy): direct HPGe gamma spectrometry with an acquisition time of 20 hours, thus achieving a lower limit of detection of 2 to 3 E-04 Bq/m^3.

5.6 Monitoring and sampling provisions for liquid releases – EP-1

5.6.1 Discharge streams and outlets

Liquid effluents are discharged via two routes, depending on the origin and type of the effluent:

Outlet 1: waste process water, after processing by the water treatment and purification plant, is collected in 8 Discharge Control Tanks (DCT) of 45 m^3; 4 of which are located in the ancillary building (AB) of block-1 and the remaining 4 in the AB of block-2. These tanks are emptied via the outbound leg of the cooling channel into the Danube River.

Outlet 2: waste sanitary water is collected in one sentencing tank, common to both blocks and located in the Sanitation Building (SB) of block 1, from where it is discharged into the KNPS sewage system.

5.6.2 Pre-discharge sampling

Operational responsibilities and chains of custody are described in the quality assured document "Instructions for the organisation of the radiation monitoring of liquid releases from EP-1".

- **Discharge control tanks (process waste water)**

Before a tank is discharged a sample is measured to verify the volumetric total beta activity of its content in order to ensure compliance with the statutory discharge limitation of 370 Bq/l (excluding Tritium). The measurement must achieve a MDA (Minimum Detectable Activity) of 6.5 Bq/l. The DCTs are sampled by staff from the WCH and PHCHC Section. An aliquot of the sample is used for the compliance measurement; the remainder is transferred to the RCH Section for further processing (generate composite samples, the assessment of which will generate the discharge accountancy values). The sample transfer also includes the report sheet from the operational monitoring (measurement result, volume discharged).

- **Sentencing tanks (sanitary waste water)**

The procedures are identical to the ones for the process waste water stream; except that the discharge limitation is set at 11 Bq/l and that the required MDA is set at 1.5 Bq/l. The responsibility for the sampling operations lies with the RTC Group (Radiometric and Technology Control).

5.6.3 Discharge accountancy

The Radiochemistry Section collects all pre-discharge samples and processes them into composite samples proportional to discharged volumes. Gamma spectrometry and total alpha counting is performed by the RCH, all other assessments are conducted by the RM Department:

Sample type	Analytical method	Sample preparation	Measurement geometry	Time (sec)
Waste process waters	Gamma spectrometry	Composite weekly sample. Direct measurement. I-131, Ba-140, La-140.	Plastic 500 ml bottle	4 E+04
		Composite monthly sample. Direct measurement. Other radionuclides.	Plastic 500 ml bottle	6 E+04
	Total alpha activity	Composite monthly sample. Evaporation to dryness.	Sample insert ∅ 52mm	1 E+04
	LSC for Tritium	Composite monthly sample.	Water sample + LSC cocktail	1.8 E+04
	Alpha spectrometry	Composite quarterly sample. Radiochemical separation.	Electro deposition on stainless steel disc ∅ 20 mm, at 5 mm distance	6 E+05
	Beta counting for Strontium-89 and -90	Composite monthly sample. Radiochemical separation.	Carbonate or Oxalate residue on filter paper, ∅ 50 mm under the detector.	6 E+03
Waste sanitary waters	Gamma spectrometry	Composite monthly sample. Direct measurement.	Plastic 500 ml bottle	6 E+04

The detection limits achieved in the year 2007, for the acquisition times given in the table above, have been below the values given hereafter (in Bq/m^3):

Cs-137	Co-60	I-131	Sr-90	H-3	Pu-239+Pu-240	Total alpha	Am-241 Cm-242+Cm-244
1 E+03	8 E+02	2 E+03	1 E+02	1 E+04	4 E-02	6 E+01	5.3 E-02

Details about laboratory instrumentation, data management and QC are given in Appendix 4.

5.6.4 Discharge monitoring

The ORDC of EP-2 is responsible for the operational monitoring during discharges. Operational responsibilities are described in the (quality assured) document "Instructions for the utilization of the data from the Automatic Information System for Radiation Monitoring of Waste Process Water and Waste Sanitary Water (AISRMWW)".

The AISRMWW system covers the whole of the KNPS site and consists of five automated water monitoring stations WMS-1 to WMS-5:

- WMS-1 for continuous measurement of activity in the outbound leg of the cooling channel. The measurement point is situated where mixing between discharges and cooling water is complete.

- WMS-2 and WMS-3 for continuous measurement of EP-2 sanitary waste water (respectively originating from the controlled zones and clean zones) before their arrival at the purification plant.
- WMS-4 and WMS-5 for continuous measurement of waste process water released from the DCTs of EP-1, respectively located within AB-1 and AB-2.

Note: A sixth WMS is being commissioned and will monitor the discharges from the DCTs of EP-2.

Data acquired by the WMS is transferred by cable to a central control unit for data processing, operational diagnostics, alarm raising, on-line display of information and storage.

WMS characteristics:

Detector	scintillation probe 3”x3” NaI/Tl type 76BS76/3-E2-X
Volume of the measurement chamber	9.5 dm^3
Flow rate	1 dm^3/min
Measurement cycle	60 sec
Measurement range	1 E+04 – 5 E+06 Bq/m^3
Calibration source	Cs-137

Alarm thresholds are set as follows:

Alarm thresholds WMS 1	Warning: 1.85 E+05 Bq/m^3 Emergency: 3.7 E+05 Bq/m^3
Alarm thresholds WMS 2 and 3	Warning: 5.5 E+04 Bq/m^3 Emergency: 3.7 E+05 Bq/m^3
Alarm thresholds WMS 4 and 5	Warning: 3.7 E+05 Bq/m^3 Emergency: 1.85 E+06 Bq/m^3

AISRMWW systems are verified by the Bulgarian Metrological Institute on a yearly basis. The verification activities consist of: maintenance, calibration verification, recalibration if necessary, issuing a verification certificate and to apply validation stickers/tags to the verified piece of equipment.

5.7 Monitoring and sampling provisions for liquid releases – EP-2

5.7.1 Discharge streams and outlets

Discharges, after waste water treatment, into the outbound leg of the cooling channel originate from the following water treatment plant items located in AB-3:

- DCTs 0TR80B01 and 0TR80B02 that collect rinsing water from the ion exchangers.
- DCTs 0TD30B01 and 0TD30B02 that collect waste water from the Boron purification system.
- DCTs 0UN30B01, 0UN30B02, 0UN40B01 and 0UN40B02 that collect potentially active sanitary waste waters.
- DCTs 0UG50B01 and 0UG50B02 that collect laundry waste waters.

5.7.2 Pre-discharge sampling

Operational responsibilities and chains of custody are described in the quality assured document "Guidelines on the organization of the radiation monitoring of liquid releases from Units 5-6 and AB-3".

- **Discharge control tanks (process waste water)**

See section 5.6.2 above, except that two 1000 ml samples are taken, one for total beta count (MDA of 3 Bq/l), the second being transferred to the RCH Section for further processing.

- **Sentencing tanks (sanitary waste water)**

See section 5.6.2 above, except that the responsibility for the operations lies with the WCH and PHCHC Section.

5.7.3 Discharge accountancy

The Radiochemistry Section collects all pre-discharge samples and (after having performed a direct gamma spectrometry analysis) processes them into composite samples proportional to discharged volumes for later assay of Strontium, Tritium and alpha spectrometry. Tritium and alpha emitters are assessed by the RM Department.

Sample type	Analytical method	Sample preparation	Measurement geometry	Time (sec)
Waste process waters	Gamma spectrometry	Direct measurement.	Marinelli beaker 1000 ml	3.6 E+03
	Total alpha activity	Composite monthly sample. Evaporation to dryness.	Sample insert ∅ 52mm	6 E+03
	LSC for Tritium	Composite monthly sample.	Water sample + LSC cocktail	1.8 E+04
	Alpha spectrometry	Composite quarterly sample. Radiochemical separation.	Electro deposition on stainless steel disc ∅ 20 mm, at 5 mm distance	6 E+05
	Beta counting for Strontium-90	Composite monthly sample. Radiochemical separation.	Carbonate or Oxalate residue on filter paper, ∅ 50 mm under the detector.	6 E+03
Waste sanitary waters	Gamma spectrometry	Direct measurement.	Marinelli beaker 1000 ml	6 E+04
	LSC for Tritium	Composite monthly sample	Water sample + LSC cocktail	1.8 E+04

The detection limits achieved in the year 2007, for the acquisition times given in the table above, have been below the values given hereafter (in Bq/m³):

Cs-137	Co-60	I-131	Sr-90	H-3	Pu-239 +Pu-240	Total alpha	Am-241 Cm-242+Cm-244
1.4 E+03	1.2 E+03	2 E+03	2 E+00	5 E+03	8 E-03	5.5 E+01	5 E-03

Details about laboratory instrumentation, data management and QC are given in Appendix 4.

5.7.4 Discharge monitoring

See section 5.6.4 above.

5.8 Liquid effluent streams from the RWTF and the SFSF

Radioactive waste process water from the RWTF is transferred for treatment to AB-3 of EP-2; waste water from SFSF is transferred for purification to AB-2 of EP-1.

5.9 Independent monitoring of discharges

Although the NRA as licensing authority has a number of on-site inspectors, a programme for independent validation of discharge data from the KNPS is not in place. Discharge reporting by the operator is only verified against the various statutory discharge limitations (paper checks).

6 VERIFICATION ACTIVITIES - RADIOACTIVE DISCHARGES

6.1 Introduction

The verification team visited:

- The monitoring/sampling devices for airborne discharges at the followings ventilation stacks:
  - EP-1: VS-2 on Units 3+4;
  - EP-2: VS-5 on Unit 5 (internal + external stack) and VS-3 on the AB;
  - SFSF: VS-4.
- The discharge sentencing tanks and related monitoring/sampling devices for liquid discharges from EP-1 (Units 3+4) and EP-2.
- The 4 dosimetry control rooms (Units 1+2, Units 3+4, Units 5+6 and SFSF).
- The analytical laboratories for discharge samples.

6.2 Airborne discharges

At the locations visited, the verification team confirmed the existence and functionality of the monitoring and sampling provisions as described in sections 5.3, 5.4 and 5.5 above.

<u>Findings and related observations</u>

The team noted that:

(1) Back-up power supplies to ensure continuous operation of the sampling and monitoring systems are present.

(2) System components were appropriately tagged with calibration and maintenance information stickers from the Bulgarian Metrological Institute (BMI). Upon request the operator provided the team with the state-issued calibration certificates for the DAMS systems and related sample line flow meters. A regulatory requirement (Article 5 of the Bulgarian Measurement Law) enforces the operator to outsource the calibration of systems and equipment that is classified as

'environment-related', in this case to the BMI. Any other calibrations are performed internally by the KNPS metrology department, in accordance with specific SOPs.

(3) Isokinetic sampling at Units 5+6 is ensured (upon request the operator showed technical drawings and/or engineering reports to that effect). The sampling lines, where appropriate, are covered in isothermic mantels.

(4) Despite the fact that the latest authorisations, enforced since August 2007 for VS-5 and October 2007 for VS-6, contain statutory limits for the discharge of H-3 and C-14, equipment for the monitoring/sampling of these radionuclides is not present.

<u>*It is suggested*</u> *that the Ministry of Economy and Energy (as sponsoring authority) and the Nuclear Regulatory Agency (as licensing authority), as a matter of priority, take all steps necessary to equip the Kozloduy NPS with operational facilities for monitoring airborne discharges of tritium and carbon-14, for all stacks for which a discharge authorisation is in force.*

(5) The activity warning and alarm thresholds that were introduced in the monitoring equipment installed on the SFSF stack (VS-4) were not in compliance with the values as required by the related SOP.

<u>*It is suggested*</u> *that the Nuclear Regulatory Agency requires its on-site inspector in charge of radiation protection matters to perform a systematic check and validation of the settings of warning and alarm thresholds on those facilities that are continuously monitoring the discharge of gaseous effluents into the environment.*

6.3 Liquid discharges

At the locations visited, the verification team confirmed the existence and functionality of the monitoring and sampling provisions as described in sections 5.6 and 5.7 above

<u>Findings and related observations</u>

The team noted that:

(1) The discharge control tanks are not homogenised before sampling. The sample taken is thus not representative for the content of the tank to be discharged. Hence, the accountancy of the source term of the individual discharges, based on the analytical results of the sample, is not satisfactorily established.

The discharged volumes are manually registered from a flowmeter located downstream from the discharge control tanks. This flowmeter registers the throughput in cubic meters up to the third decimal. These decimal values are however not written down on the registration forms: this introduces an unnecessary lack of precision (bias) in the discharge accountancy.

<u>*It is suggested*</u> *that the Nuclear Regulatory Agency enforces the operator of the Kozloduy NPS to ensure that discharges of liquid effluents into the environment are more strictly accounted for.*

(2) Kozloduy NPS operations have no automatic means to interrupt a routine discharge should an activity concentration above defined discharge limits for a discharge control tank occur (as a back-up to analytical measurements on the pre-discharge sample).

The on-line total-gamma monitors (WMS stations) that are currently checking the volumetric activities in some parts of the discharge lines are not fulfilling the purpose described above because their function is solely for emergency control: an on-line demonstration of the WMS-4 monitor and a review of logged data confirmed that its detection sensitivity is insufficient to measure routine discharges.

The WMS, in its function of emergency control device, if triggered, would raise an alarm that starts an operational decision taking procedure. This in turn may then possibly lead to a manual intervention to close the discharge valve of the tank in question (if this tank would still have some contents left within it). The verification team takes the point of view that such a procedure is slow and lacks efficiency. The verification team believes that should an alarm occur this would inevitably lead to a full discharge into the environment.

The current practice to send an operator to manually operate the discharge valve (in normal operation or in emergency conditions) cannot be considered as a satisfactory procedure.

Restricting liquid discharge control to sample analysis only is not fully satisfactory. Nowadays, it is generally considered good practice to have a second level of discharge control on liquid effluents. Such a second level is installed on the discharge line immediately after (or before) the discharge valve and consists of a continuously operating gamma monitor. This monitor, when the alarm level is reached, induces an automatic closure of the discharge valve of the tank. At the same time the system closes the discharge line downstream of the monitor. In order to be fully operational such a system also provides for the necessary pipes and pumps that allows the recuperation of the discharged volume between the tank and the valve downstream of the monitor.

<u>It is suggested</u> that the Ministry of Economy and Energy and the Nuclear Regulatory Agency consider the benefit of installing additional means of liquid discharge control. Current provisions are unsatisfactory insofar that the absence of automated emergency closure of discharge tank valves may lead to uncontrolled release of activity into the environment.

(3) The operational decision procedure that leads to a discharge into the environment is not unequivocally established. Although *de facto* responsible, operations rely on a 'green light' telephone call from the laboratory without having seen and countersigned the laboratory's sample analysis record. Countersigning takes place at an ulterior point in time. This *modus operandi* has the potential to lead to misunderstandings and subsequent uncontrolled discharges.

<u>It is suggested</u> that the Nuclear Regulatory Agency require the operator of the Kozloduy NPS to ensure that the chain of custody, where it concerns the responsibility for discharging liquid effluents into the environment, is strengthened.

6.4 Dosimetry control rooms

The team visited the dosimetry control rooms where it could satisfactorily verify that the online transmission of information from the various monitoring systems present on site was operational.

The team has no particular observation to formulate.

6.5 Analytical laboratories for discharge samples

The team visited the following laboratories:

- The WCH & PHCHC section laboratory of EP-1.
- The RTC laboratories belonging to the ORDC sections of EP-1 and EP-2.
- The RCH section laboratories of EP-1 and EP-2.
- The PHCHC section laboratory of EP-2.

In these laboratories the team verified the adequacy of the analytical systems in place, including various aspects of quality assurance and control (working instructions, methodologies, calibration, maintenance, bookkeeping of results, reporting etc.).

Findings and related observations

The verification team confirmed the existence and functionality of analytical equipment and quality assurance programmes as described in appendix 4 of this report.

The team noted that:

(1) The laboratories are adequately equipped.

(2) Maintenance and calibration of the measurement devices are properly ensured.

(3) SOPs for sampling, sample preparation, sample measurement and reporting of results are in place and easily accessible.

(4) Archiving of sample-related source documents is correctly implemented.

The team has no particular observation to formulate with respect to points (1) to (4).

(5) With respect to the EP-1 accountancy laboratory, it was noted that:

- the laboratory is situated in a non-controlled (clean) area;
- the controlled zone lies beyond one of the walls of the laboratory;
- samples are transferred from the controlled into the clean area through a window-protected opening in the separation wall;
- samples are transferred without monitoring or health physics clearance certificates.

The verification team believes the above to be a shortcoming: standard health physics rationale requires materials that leave controlled zones to be duly monitored and cleared. It would also be beneficial, in terms of avoiding cross-contamination and subsequent risk of interference with measurement results, to enhance the physical segregation between the laboratory and the controlled area by replacing the current window with a two-way airtight lock.

It is suggested that the Nuclear Regulatory Agency requires its on-site inspector in charge of radiation protection matters to perform a systematic check and validation of the operator's SOP(s) that cover the transfer of samples between controlled and clear zones within the Kozloduy NPS.

(6) Finally, it is recalled that the European Commission issued Recommendation 2004/2/Euratom [(6)] wherein substitution rules for values below the detection limit are presented. These rules apply independently from the degree of measurement precision (detection limit) achieved and are proposed to avoid unnecessary over- or underestimation of discharged activities. These substitution rules are in line with ISO standard 11929-7:2005.

It is suggested that the Nuclear Regulatory Agency consider the benefits of revising its regulatory requirements for substitutions of analytical results below detection limits by bringing these requirements in line with Commission Recommendation 2004/2/Euratom and ISO standard 11929-7:2005.

6.6 Check monitoring by the regulatory authority

The verification team noted the absence of an independent check monitoring programme by the NRA.

6 Official Journal L 002, 06/01/2004 P. 0036 - 0046

The NRA, as licensing authority, is in charge of issuing the discharge limitations for radioactive effluents from the Kozloduy NPS.

Currently, the validation of the operator's discharge reporting is reduced to paper checks of the data provided against the regulatory discharge limits.

It is accepted good practice in the European Union that the regulatory authority itself sets up and implements a systematic and independent sampling and analysis programme on the discharges of radioactive effluents. To that effect the regulator may have its own sampling systems in place or have a co-operation agreement with the operator where the latter provides the samples (under random supervision of an inspector). Analysis of these samples is then done at the regulator's laboratory (or by a contractor) and results obtained are compared with those reported by the operator. This comparison provides the basis for a validation of the operator's discharge data.

Furthermore, the regular transmission of the results of the regulator's samples to the operator may provide the latter with valuable means of performing analytical quality assurance checks on its own measurements.

It is suggested that the Nuclear Regulatory Agency, in order to fully discharge its responsibilities as the licensing authority for discharge control, puts in place a comprehensive and independent check monitoring programme on the discharges of radioactive effluents from the Kozloduy NPS.

7 ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

7.1 Introduction

This summarises the environmental radioactivity monitoring programmes (ERMP) that are implemented in Bulgaria relating to the radiological impact of KNPS upon the environment within 100 km of KNPS:

Monitoring of the radiological impact of operations of KNPS upon the environment, under routine conditions, is composed of three elements:

- The KNPS operator's own ERMP.
- The statutory ERMP of the MEW and the MH.
- Non-statutory monitoring by the NIMH and the MSPDA.

The NRA has no sampling environmental monitoring programme of its own. However, it does participate to annual meetings where the results of common samples are evaluated by KNPS, the Ministry of Health, and the Ministry of Environment and Waters. KNPS's environmental monitoring programme is drawn up in consultation with the NRA, MEW, and MH and is formally approved by the NRA.

A brief overview of the role assigned to each body is given below followed by a detailed description of the implementation of each component of the national programme. Since KNPS is the only large nuclear facility in Bulgaria, much of the national system is deployed in the Kozloduy 100 km zone.

The Danube, roughly 3km to the north of KNPS, forms the boundary with Romania. All sampling points, monitoring stations etc., belonging to these ERMP are located on Bulgarian territory.

7.2 The Operator's ERMP

The KNPS environmental monitoring programme is drawn up in consultation with the MEW, MH and NRA and is authorised by the NRA. The KNPS monitoring programme includes both continuous monitoring and laboratory analysis of radionuclides. The programme in force at the time of the verification dated from 2004 (Authorisation O-2882/10.01.2004).

The programme includes a total of 36 monitoring stations for airborne particulates, wet/dry deposition, soil sampling, and vegetation sampling. In addition to these fixed stations, samples are also collected from other locations up to 100 km distant from the site. Some samples cover the environment: surface and ground waters; soils and river or lake sediments, river and lake algae, vegetation. Other samples cover the food chain: drinking water, milk, fodder and cereals, meat, fish, drinking water.

KNPS possesses a mobile laboratory for performing measurements in-field or for use in emergency situations.

KNPS also operates eight monitoring stations in the 3km zone in order to continuously monitor the ambient doserate and the concentration of I-131 in air.

The sampling programme, amounting to around 3500 samples per year, is presented in summary form in Appendix 5 and the various sample types are discussed in further detail below.

7.2.1 Fixed monitoring stations

KNPS operates a network of 36 fixed monitoring stations, (100 km zone around the NNP) housed in concrete block-houses around the KNPS site. 33 of the monitoring stations are located within the 12 km control area including at the site boundary, whilst the remaining 3 stations are located in the nearby towns of Lom, Pleven and Berkovitza. Most of the monitoring points are located in agricultural areas on untilled ground.

KNPS classifies these stations as being of either Type A or Type B, where:

Type A stations are for sampling airborne particulates using high volume air sampling equipment; collecting wet and dry deposition, and soil and vegetation sampling. Periodic measurements of the dose rate are performed at these locations and the total dose equivalent is measured over a period using TLDs. There are a total of eleven Type A monitoring points.

Type B stations are for the sampling of wet and dry deposition, soil and vegetation. Dose rate measurements are performed periodically and the integrated dose equivalent is measured with TLDs. There are 25 Type B monitoring points.

The Type A stations are equipped with high volume air samplers (throughput 80 to 100 m^3/h). The filters themselves are sourced in Russia (FPP-15-1.5, Ø 30 cm), the pumps are manufactured by Aeroterm Ltd., and the digital flow meters are model Rosenberg RS-250. (There is an additional control station in the 100km zone, in the direction of the prevailing winds).

Five days after changing, filters are ashed and measured for total beta activity using gas-flow proportional counters. A monthly composite sample is prepared from the weekly samples for retrospective balance measurements (typical measurement time 60.000 seconds giving an MDA of the order of 1µBq/m3.

Thirty-three of the stations are equipped with collectors for gathering wet and dry deposition. The collectors, manufactured by KNPS, are of standard design. Collectors are positioned 1m80 above the ground and have a sampling surface of 0,250 m2. Samples are collected monthly and analysed in the Radiation Monitoring laboratory. The filter paper, together with the evaporated wet deposition are ashed and then measured for total beta activity. For a 100 minute measurement time, the MDA for total beta is of the order of 10mBq per square metre per day. Cs-137 is also measured by gamma spectrometry; the MDA for 20.000 seconds measurement time being around 30mBq per square metre per day. In addition, three-monthly composite samples are prepared for evaluation of the Sr-90 content.

7.2.2 Volumetric activity in water

There are several sampling points for surface waters from the Danube, Ogosta, and Tzibritza Rivers as well as the Shishmanov Val Lake. Sampling frequencies vary from weekly to six-monthly. All samples are analysed for total beta activity and tritium. In addition the samples from the Danube are evaluated for Sr-90 and Cs-137.

Total beta activity is determined by evaporating a 1 litre sample to dryness and measuring the residue for 100 minutes, giving an MDA of around 0.034 Bq/l. Tritium is evaluated after the sample has been concentrated by distillation and a sub-sample mixed with scintillation cocktail (Ultima Gold LLT-Finland). The sample is measured on a Wallac scintillation counter for 500 minutes giving an MDA for tritium in the range 1.6 – 4.6 Bq/l.

Sr-90 activity is determined by preliminary radiochemical separation and concentration of radio-strontium from the sample. 40 dm^3 samples are composed from weekly sub-samples. The method applied is based upon co-precipitation of strontium and calcium as carbonates, separation of strontium from calcium with the aid of sodium hydroxide followed by radiometric measurement of Y-90 after attainment of secular equilibrium with Sr-90. The chemical yields for strontium and yttrium are determined gravimetrically and by titration respectively. The same sample is used to isolate Cs-137 by co-precipitation with ammonium phosphorous molybdate followed by gamma spectrometry measurement of the preparation. The obtained activities are corrected for chemical yield. A measurement time of 100 minutes gives an average MDA for Sr-90 of 0.8 mBq/l. Gamma spectrometry measurement of 60000 seconds gives an MDA for Cs-137 in the range 0.5 to 1.5 mBq/l.

7.2.3 Drinking water

Drinking water from Kozloduy and Oriahovo towns, Harletz village, and KNPS is sampled monthly for analysis of total beta activity and tritium. Sr-90 and Cs-137 are determined twice a year for samples taken from Kozloduy, Harletz, and KNPS and quarterly for samples from Oriahovo. Drinking water samples are analysed using the same techniques as for surface water samples.

7.2.4 Monitoring of soils and water sediments

There are a total of 37 soil sampling points in the 100 km zone.

Soil samples are collected in the immediate vicinity of Type A or Type B sampling stations and, wherever possible, are taken from undisturbed soil. A sample is composed of six subsamples taken in a row of 80 mm cores to a depth of 5 cm.

Soil is dried to constant weight, then milled, sieved and homogenised. Aliquots from the prepared samples are measured in Marinelli beakers, without additional treatment, by gamma spectrometry. Sr-90 is separated by radiochemical methods and then determined by radiometry after secular equilibrium has been attained.

7.2.5 Sampling and analyses of bottom sediments

Sediment samples are collected from the Danube, the Ogosta and Tzibritza rivers and Shishmanov Val Lake at the same locations as the surface water samples. The frequency of sampling for the various locations is quarterly for the outlet channel, semi annual for the other locations on the Danube River and annual for the inner lakes and rivers. Sediments from natural water sources are sampled using core sampling equipment manufactured by Eijelkamp.

Samples are prepared and analysed as described above for soil samples, i.e. direct gamma measurements and radiochemical separation for Sr-90.

7.2.6 Monitoring of milk

Cows' milk is sampled on the premises of three dairy producers located within the 30 km zone. Six-litre samples are collected in plastic containers. Samples are analysed monthly for total beta activity for gamma emitting radionuclides. A 2 dm^3 sub-sample is directly measured by gamma spectrometry in a Marinelli beaker for 60.000 seconds, giving an MDA for Cs-137 of around 100 mBq/l. A 3 dm^3 sub-sample is ashed at 450°C and 300 mg of the ash thus obtained is analysed for total beta activity.

Subsamples from the monthly samples from each location are combined for quarterly radiochemical analyses of Sr-90. The MDA for Sr-90 (measured via its daughter Y-90) with a measurement time of 100 minutes is around 5 mBq/l.

7.2.7 Danube fish

Fish are caught using nets or fishing rods at two locations in the River Danube: upstream of KNPS, where the cooling water channel leaves the river and downstream of KNPS where the cooling water outlet channel enters the river.

Bones and meat are analysed separately since caesium accumulates in meat and strontium in bones. Cs-137 in meat is measured directly in Marinelli beakers by gammaspectrometry. Sr-90 in bones is determined by radiometric counting after ashing at 450°C and radiochemical separation.

7.2.8 Terrestrial and aquatic biota and flora

There are six control points for sampling vegetation (grass) on site at KNPS and a further six points offsite within the 100 km area. Samples are taken semi-annually on-site, quarterly at the nearby towns of Kozloduy, Harletz and Oriahovo, and annually at the more distant towns of Lom, Pleven and Berkovitza.

Samples (around 2 kg per sample) are taken using clippers and a wooden frame to ensure reproducibility. Samples are cut, dried, milled and homogenised, and then dried to constant weight. Measurements of gamma emitters are performed in Marinelli beakers without further treatment. Samples to be analysed for Sr-90 are ashed at 450°C followed by dissolution in aqua regia, and calcium separation by treatment with NaOH. Y-90 is determined radiometrically once the Y-90/Sr-90 equilibrium is reached.

Algae from lakes and rivers are sampled close to the water and sediment sampling locations on the River Danube, the Shishmanov Val Lake, and the Ogosta and Tzibritza rivers. Samples are takenat the same places or close to the water and sediment sampling locations.

Algae are dried to constant weight and homogenized. Gamma spectrometry is performed directly upon the dried algae in Marinelli beakers. Sr-90 determinations are performed on algae samples in the same way as on vegetation samples.

7.2.9 Agricultural products

Fodder and cereals typical of the region (wheat, barley, sunflower) are sampled within the 3 km zone, which is divided into 4 sections for this purpose. Analytical methods are similar to those described above for vegetation.

7.2.10 Environmental doserate monitoring

KNPS follow ambient gamma dose rates using a mix of fixed, continuous gamma monitors; dosimeters for total dose; and regular measurements at fixed locations using hand-held monitors.

10 thermoluminescent dosimeters (TLD) are located along the site perimeter and a further 22 are located in populated areas up to 100 km from KNPS. The TLDs (TLE-4 manufactured by Protecta) are specifically designed for environmental monitoring and are exposed for periods of three months.

Portable dose rate meters are used to measure the equivalent dose rate - on a weekly basis at Type A points and on a monthly basis at Type B points and other points in the 100 km zone. The doserate meters are model Automess 6150 AD2/ADT, AD6 with a measurement range of 100 nSv/h to 10 mSv/h.

The 3 km zone contains 8 automatic stations for continuous monitoring of dose rate and the volumetric activity of I-131. The system also includes two base stations located on the nuclear site. This system is known as the Automatic Information System for Ambient Radiation Control, (AISARC). Its main purpose is to allow for decision making and undertaking measures on radiation protection of personnel and population from the region, if a radiation emergency should occur. The regulators therefore have real time access to AISARC. Nonetheless, the system is also used for routine environmental monitoring, and since 1999 data gathered by AISARC feeds into BULRAMO, the Bulgarian national monitoring network. (Radiation conditions on-site are monitored by a separate system known as the Automatic Information System for Onsite Radiation Monitoring, AISORM).

AISARC has provision for setting alarms, data collection, processing, verification and back-up, system diagnostics and database queries. Data transmission is via cable with duplicate transmission through a wireless channel. The database is based on SQL architecture. Backup is to two separate hard disks at different locations.

The detectors for the dose rate measurements are manufactured in Russia (BDMG - 02P, BDMG-41-01) and Belarus (BDKG - 08). The concentration of I-131 is measured using LB104B detectors manufactured by Berthold Technologies, and filters of type Auer 89B/St. Annual verification of the system is performed by the Bulgarian Metrological Institute.

AISARC is summarised in the below table.

Measured parameters	Equivalent doserate. Volumetric activity of I-131
Sampling Method	Air sampling using vacuum pumps. Flow rate 1 to 5 m^3/h.
Measurement ranges	**Equivalent doserate** From 0.8 E-07 Sv/h to 5 Sv/h, covered by 3 measurement channels: Measurement channel 1 - from 80 nSv/h to 100 μSv/h; Measurement channel 2 - from 10 μSv/h to 100 mSv/h; Measurement channel 3 - from 100 nSv/h to 5 Sv/h; (duplicates measurement channels 1 and 2) **Volumetric activity of I-131** 0.9 to 7240 Bq/m^3
Gamma energy range	Dose rate 60 keV – 3000 keV
Measurement frequency	1 minute
Detection limits	Dose rate: 80 nSv/h Volumetric activity of I-131: 0.9 Bq/m^3
Warning and alarm levels	**Equivalent Doserate** Warning threshold: 0.3 μSv/h Alarm threshold: 0.6 μSv/h **Volumetric activity** Warning threshold: 10 Bq/m^3 Alarm threshold: 17 Bq/m^3

7.2.11 Weather monitoring system

The Weather Monitoring System (WMS) provides information on local weather for use both during normal operation and during emergency situations. The system continuously tracks weather conditions. Data transfer to the national system for continuous radiation monitoring (BULRAMO) is performed by wireless channel.

WMS was manufactured in Bulgaria and consists of the following items:

- three automatic weather stations type MS&E-3RMD;
- a telecommunications network, based upon digital USW radiochannel exchange;
- software for the control of the system, data acquisition and backup, operational verification and diagnostics, pre-processing of weather data, and communications.

A spare weather station is available in case of failures.

The following parameters are recorded:

Temperature	-35 °C to +70 °C;
wind speed and direction, at 10 m height	0.4 m/s to 40 m/s
precipitation	unlimited
precipitation intensity	1.2 mm/h - 180 mm/h
relative humidity	25% - 99%
atmospheric pressure	600 hPa - 1050 hPa
atmospheric stability – Pasquill	

7.3 The National ERMPs

7.3.1 Introduction

The MEW and the MH have statutory duties to monitor environmental radioactivity throughout Bulgaria, including in the vicinity of Kozloduy.

The MEW's national programme actually consists of 6 regional programmes. The execution of these regional programmes is entrusted the EEA's Burgas, Vratsa, Varna, Stara Zagora, Montana, and Pleven offices. The Vratsa programme is of the most relevance to the monitoring of the environmental impact of KNPS. The programme in force at the time of the verification visit was R2-277 dated 06.04.2007. It includes 23 sampling locations for soil and sediments, 16 sampling locations for surface and ground waters, and 2 locations for air sampling.

The NRA has no environmental monitoring programme of its own. However, it does participate to annual meetings where the results of common samples are evaluated by KNPS, the Ministry of Health, and the Ministry of Environment and Waters. KNPS's environmental monitoring programme is drawn up in consultation with the MEW, the MH and the NRA and is formally approved by the NRA.

NIMH is not a regulatory body and its sample taking facilities are not part of the national programme for monitoring radioactivity in the environment under routine conditions, although in the case of a radiological emergency NIMH are under a statutory obligation to report their monitoring results to the NRA. Otherwise NIMH do not report to the NRA or the MEW, but NIMH does publish on the internet an annual report summarising the findings of its monitoring programmes.

The verification team suggests that in order to draw the full benefit from NIMH's work, consideration be given to including the results of NIMH's monitoring programme insofar as they are pertinent to Kozloduy in the agenda of the annual meeting between KNPS, NRA, MEW and MH where environmental monitoring results are compared.

7.3.2 Responsible bodies

- Environmental Executive Agency

The EEA's ERMP is developed within the EEA and is formally approved by the MEW in the form of a Ministerial Decree.

The EEA follows levels of radioactivity in the environment both on-line and off-line:

- On-line through the automated system for on line surveillance (BULRAMO).
- Off-line through laboratory measurements of samples.

The monitored parameters are:

- Gamma-background in the country.
- Radionuclides in atmospheric air.
- Natural and anthropogenic radionuclides in soils, sediments, wastes.
- Total alpha- and beta- activity of surface, ground and waste waters.

- Cs-137 and H-3 specific activity of surface, ground and waste waters.
- radon from uranium mining, other ore mining, or the energy industries.

• Ministry of Health

The National Centre for Radiology and Radiation Protection (NCRRP) is a specialised administration with the Ministry of Health, charged with executing the Ministry's policy on protecting the public against ionising radiation.

There are a total of 28 Regional Inspectorates for the Protection and Control of the Public Health (RIPCPH) carrying out activities concerning public health. The RIPCPH has radiation control units, charged with monitoring in relation to public health located in Burgas, Varna, Vratsa, Plovdiv and Rousse.

• National Institute for Meteorology and Hydrology

NIMH is the national hydro-meteorological authority of the Republic of Bulgaria. It is responsible for meeting Bulgaria's obligations towards the World Meteorological Organization (WMO). The institute began its work on monitoring of radiation in the environment in response to fall-out from nuclear weapons testing in the late 1950s and is particularly active in relation to the spread of large releases, and their computer modelling.

• Ministry of State Policy for Disasters and Accidents

The Directorate General of the National Service for Civil Protection (DGNSCP), a service within the Ministry, co-ordinates a network of 335 municipal and 28 County radiation surveillance posts throughout Bulgaria for purposes of civil protection. The posts are staffed by personnel from county and municipal administrations. In addition, there are a further five radiation surveillance posts within the Kozloduy 30 km zone. Measurement results are forwarded daily to the Bulgarian Council of Ministers.

The activities of the DGNSCP are complemented by those of the County Directorates for Civil Protection, which carry out environmental radioactivity monitoring, provide guidance to municipal specialists, co-ordinate radiation measurement activities at county and municipal levels and treat emergency monitoring data for transmission to the DG National Service for Civil Protection.

7.4 NERMP - external gamma doserate monitoring

7.4.1 Environmental Executive Agency

In accordance with the national Regulation, the Environmental Executive Agency is responsible for operation and maintenance of the national automated system for online monitoring of the gamma background - BULRAMO. The system comprises 26 local measurement stations across Bulgaria, with the highest concentration of stations in the Kozloduy 100 km zone. In 2000, the KNPS gamma monitoring system, AISARC (see above), was connected to BULRAMO via a bi-directional link. BULRAMO is intended primarily as an early warning measurement and information system for the state authorities and the population in the event of a nuclear accident.

The stations are equipped with probes covering the range 10 nSv/h to 10 Sv/h. Each station is equipped with a display screen, so that the general public can also see the measured doserate. Each station is also fitted with a rain detector, and a data logger. The probes, rain detectors and dataloggers are all manufactured by TechniData AG. Eight of the stations are also equipped with integrated weather stations.

BULRAMO Gamma Probes – Technical Characteristics

Detectors	2 x GM counters 70031E 1 x GM counter 79918E
Sensitivity	10 nGy/h to 10 Gy/h
Accuracy	± 15% (for Cs-137)
Energy range	40 keV to 1.25 MeV
Working temperature	-40°C to +60°C

Under routine monitoring conditions, the basic measured value is the 10-minute average value of the gamma background. The data gathered are transmitted every thirty minutes by 50 MHz radio to the Central Station where the data are transformed into hourly and daily average values. During emergencies, data can be transmitted to the Central Station every 10 minutes.

At the time of the visit, measurement data was available online to KNPS, Ministry of State Policy for Disasters and Accidents, the Nuclear Regulatory Agency, the Ministry of Defence, the Executive Environment Agency's Vratsa and Varna offices, and the Ministry of Health was in the process of being connected.

The monitoring stations are equipped with state-of-health indicators which can be remotely interrogated. Some maintenance functions can also be carried out remotely from the Central Station.

7.4.2 Ministry of State Policy for Disasters and Accidents

Local civil protection specialists are equipped with doserate meters of types PP51M and LB133 whilst specialists from the county Civil Protection Directorates are equipped with PM 1203 and PM 1621A. In addition, Civil Protection Directorates located in Counties neighboring Chernavoda NPP in Romania are equipped with tritium monitors. At national level, MSPDA has 7 combined field gamma-spectrometers/doserate meters of the type IdentiFINDER, two of which are equipped with supplementary neutron probes. MSPDA also has a CanberraInSpector 1000 gamma-spectrometer.

Measured radiation levels are published in the Ministry's Bulletin and are forwarded daily to the Bulgarian Council of Ministers.

7.4.3 Ministry of Health

The MH operates a single gamma doserate monitor that is located on the premises of the NCRRP in Sofia.

7.5 NERMP - air and atmospheric deposition sampling programmes

7.5.1 Environmental Executive Agency

Air sampling stations are sited in Vratsa and Montana. The stations were provided as assistance under PHARE. The stations are housed in cabins. Electronic and pneumatic elements are mounted in industry standard 19" racks. The stations are equipped with automatic, high flux sampling devices, produced in Italy, of type SEA 5002. Particles are collected on standard 47 mm diameter membrane filters. The air velocity, flowrate and volume can all be software controlled. Depending on temperature and air pressure, the typical sampled air volume is around $900m^3$, collected in 5 to 7 days.

The filters are analysed at the EEA laboratories in Vratsa and Montana using SILENA type HPGe PRGC 3022 gamma-spectrometers.

7.5.2 Ministry of Health

The KNPS site related monitoring carried out by the NCRRP encompasses 2 sampling points that are sampled 3 times per year. Samples are analysed for total beta activity, Sr-90, Cs-137, Co-60 and Be-7.

7.5.3 National Institute for Meteorology and Hydrology

NIMH operates regional radiometry laboratories located in Sofia, Plovdiv, Pleven, Varna and Burgas. Air samples are taken every day and the total beta-activity is immediately measured for analysis of short-lived beta-active isotopes. 72 and 120 hours after sampling filters are measured for long-lived beta-active isotopes. Air samples represent typically volumes of 30 to 100 m^3 of air.

In the event of abnormally high results the filters are analysed in a NIMH or partner laboratory by low background gamma spectrometry, as follows:

- Pleven and Plovdiv - using the NIMH's own gamma spectrometry facilities;
- Sofia - in the gamma spectrometry laboratory of the INRNE;
- Burgas - in the gamma spectrometry laboratory of the RIEW;
- Varna - in the gamma spectrometry laboratory of the RIPCPH.

Three types of atmospheric fallout collectors are used in the NIMH monitoring network: collection in a cylinder containing distilled water; collection on cotton; and direct collection of precipitation. The samples are transported to the above laboratories where the first analysis is of total beta-activity, which is measured 120 hours after sampling.

The first type of sample is collected in a cylindrical container having a surface area of 0.2 m^2, the interior of which is partly filled with distilled water. Sampling frequency varies from daily to monthly. Aliquots of the liquid sample are evaporated to dry residue and their total beta-activity is measured. If necessary, low background gamma spectrometry can also be performed.

The second type of collector consists of a layer of cotton spread over a horizontal plane, 1 m above the ground. The samples are ashed and total beta-activity measurement and gamma spectrometry analysis are carried out.

Precipitation samples are collected during 24 hours, every day in collection vessels. A sample of 250 cm^3 is evaporated to dryness and the total beta activity measured. Precipitation samples are also combined for alpha- and gamma spectrometry.

7.6 NERMP - water sampling programmes

7.6.1 Environmental Executive Agency

The EEA's water sampling programme encompasses surface waters and (non-drinking) ground waters. 12 surface water samples per year are taken in the 30 km zone for total beta analysis in the EEA's regional laboratory at Vratsa according to the method set out in ISO 9697. The measuring device is a calibrated low background alpha-beta counter with 12 proportional gas flow detectors of the type EBERLINE-FAG FHT 770 T12. Nine of these samples are also subjected to radiochemistry analysis for Cs-137 once a year.

On a monthly basis, the Regional laboratory in Vratsa takes samples from the port of Oryahovo on the Danube and from the Kozloduy NPP cooling water outlet channel for evaluation of the tritium content by LSC following the method of ISO 9698. These analyses are performed by the EEA's Sofia laboratory. The EEA's regional laboratory in Montana also samples surface waters for analysis in Sofia.

Once a year, EEA also takes (non-drinking) groundwater samples from wells in Hayredin, Oryahovo and Vratsa. These samples are analysed for total beta activity at the regional laboratory in Vratsa, according to the method set out in ISO 9697. The measurement is performed using a low background EBERLINE-FAG FHT 770 T12 alpha-beta counter with 12 proportional gas-flow detectors.

7.6.2 Ministry of Health

The KNPS site related monitoring, conducted by the NCRRP, encompasses 12 sampling points, seven of which are sampled 3 times per year, the others yearly. The samples are analysed in Sofia for total beta activity, Sr-90 and Cs-137.

The NCRRP and the RIPCPH implement a specific drinking water sampling programme, in accordance with the MH's drinking water quality Regulation Nr. 9/28.03.2001. Approximately 150 samples are taken per year and analysed for total beta activity, natural uranium and Ra-226. The approximately 400 sampling locations defined in the programme entail that all locations are covered over three-year periods.

7.6.3 Ministry of Agriculture and Food Supplies

MAFS (through LRRM) samples surface waters and drinking water at 24 locations throughout Bulgaria, 3 of which directly concern surface waters around the KNPS: one sample location is situated upstream of KNPS, the other two on the inlet and outlet channels of the cooling water intake.

7.6.4 National Institute for Meteorology and Hydrology

NIMH also carries out a small programme for periodic control of surface waters in Bulgaria, at ten fixed sampling stations.

7.7 NERMP - soil and sediment sampling programmes

7.7.1 Environmental Executive Agency

The Vratsa and Montana regional laboratories carry out soil and sediment sampling in relation to control of KNPS operations. In the 30 km zone samples are taken from the top 5 cm of soil whereas in the 100 km zone they are taken from the top 20 cm of soil. Dose rate measurements are also carried out at each sampling location whenever soil samples are taken.

Samples are prepared for gamma spectrometry analysis by drying, crushing, and homogenisation. Samples are analysed for Cs-137, U-238, Ra-226, Th-232, K-40 and Pb-210. The Vratsa and Montana laboratories are equipped with Silena gamma spectrometry systems using HPGe PRGC 3022 semiconductor detectors.

7.7.2 Ministry of Health

The scope of the soil and sediment sampling programme is set out in Order Nr. RD-09-361/28.07.1998 of the Minister of Health. Its execution is entrusted to NCRRP and RIPCPH.

The KNPS site related monitoring conducted by the NCRRP encompasses 17 sampling locations for soil and 12 sampling locations for sediments. Depending on the location the sampling frequency is yearly or three-monthly. Sampling and sample analysis procedures are in conformity with MH's Regulation Nr. 25/2007. Samples are assessed for Sr-90, Cs-137 and Co-60.

7.7.3 Ministry of Agriculture and Food Supplies

MAFS (through the LRRM) samples soil and sediment throughout Bulgaria. The sampling procedures and subsequent laboratory analysis of the samples taken is conducted according to the Bulgarian BDS 17.4.5.01 norm.

Four locations have been defined around the KNPS for sampling soil or sediments. As a function of the location samples are taken at various depths (0 to 5 cm / 5 to 10 cm / 10 to 20 cm / 20 to 40 cm). Samples are assessed for Cs-134, Cs-137, U-235, U-238, Ra-226 and K-40.

7.7.4 National Institute for Meteorology and Hydrology

In the framework of the international Black Sea Monitoring Programme, NIMH carries out a number of analyses, including of sand collected twice a year in the vicinity of Varna. The methodology follows that developed by the IAEA Monaco laboratory. Samples are analysed by gamma spectrometry for Ra-226, U-238, U-235, Th-232, Cs-137 and any other anthropogenic nuclides above the detection limit. Alpha spectrometry is used to determine Po-210, Pu-239/240, U-238, and U-235.

7.8 NERMP - terrestrial and aquatic biota and flora sampling programmes

7.8.1 Ministry of Health

The NCRRP and RIPCPH sample and analyse vegetation and fish in accordance with Order Nr. RD-09-361/28.07.1998 of the Minister of Health.

The KNPS site related monitoring, conducted by the NCRRP, encompasses 17 sampling locations for vegetation (grass & herbs – depending on the location once or twice a year) and 1 location were fish are sampled three times a year (Danube). Samples are assessed for Sr-90, Cs-137 and gross beta activity.

7.9 NERMP - food chain sampling programmes

7.9.1 Milk - Ministry of Health

The NCRRP and RIPCPH analyse milk (monthly) and dairy products (six-monthly) in accordance with Order Nr. RD-09-361/28.07.1998 of the Minister of Health. The sampling is carried out according to the requirements of Regulation Nr. 22/2003 of the Minister of Health on the conditions and procedures for food sampling. Samples are assessed for K-40, Sr-90, Cs-134 and Cs-137.

7.9.2 Milk - Ministry of Agriculture and Food Supplies

MAFS samples milk quarterly at 14 locations throughout Bulgaria (one sampling location is situated in the vicinity of the KNPS). The sampling procedures and subsequent laboratory analysis of the samples are carried out according to the Bulgarian BDS ISO 707 and BDS 1108 norms. Samples are taken from locally produced milk and milk products at farms, processing plants, distributing dairies and markets.

7.9.3 Mixed diet / foodstuffs - Ministry of Health

MH doesn't monitor mixed diet. The daily intake of radionuclides is assessed from statistical data on the dietary habits of the Bulgarian population and from the results from the measurement of samples from the main food groups (fruits, vegetables, meat and meat products, milk and milk products, fish, bread and cereals). Sampling is carried out according to the requirements of Regulation Nr. 22/2003. Samples are assessed for K-40, Sr-90, Cs-134 and Cs-137.

7.9.4 Foodstuffs - Ministry of Agriculture and Food Supplies

The ERMP for foodstuffs of animal origin is implemented by the CLVSEE. The 2007 ERMP addressed the following media:

- livestock ± 70 samples (cattle, pigs, sheep, goats);
- farm-bred birds ± 20 samples (chicken, ducks);
- raw milk ± 115 samples (cows, sheep);
- eggs ± 65 samples (hens, quails);
- farm-bred game ± 25 samples (pheasants);
- rabbits ± 15 samples;
- honey ± 15 samples;
- wild game ± 100 samples (boars, partridges, quails, pheasants);
- wild fish ± 60 samples ([silver]carp, trout, sturgeon).

The sampling procedures are laid down in the following Bulgarian norms:

- BDS ISO 3100/1 and /2; BDS 1328 - meat and meat products;
- BDS 14593 - poultry and poultry products;
- BDS 4336 - eggs and egg products;
- BDS 3419 - fish and fish products;
- BDS 3050 - bee honey.

The ERMP for foodstuffs of non-animal origin is implemented by the LRRM. This ERMP, in 2007, addressed the following media: wheat, barley, corn and sunflower seeds.

8 LABORATORIES INVOLVED IN THE REGULATORY CONTROL OF KNPS

8.1 Introduction

This section serves to provide a brief overview of the laboratories involved in monitoring of environmental radioactivity in relation to the operations of KNPS. It covers KNPS's own environmental laboratory as well as those operated by the regulatory authorities and other bodies.

8.2 Kozloduy Environmental Monitoring Laboratory

The KNPS service responsible for monitoring environmental radioactivity is known as the Radio-ecological Monitoring Department (RMD). Administratively, it forms part of the KNPS Quality and Safety Directorate. Apart from monitoring of radiation in the vicinity of KNPS and in the 100 km zone, the RMD is also charged with determination of alpha and strontium in gaseous releases and alpha, strontium, and tritium in liquid discharges as well as evaluating the population dose due to airborne and liquid discharges from KNPS.

The laboratory responsible for off-site sample taking and analysis is located near the KNPS site. It is equipped with instrumentation for performing low background measurements, liquid-scintillation counting, gamma spectrometry, alpha spectrometry and dosimetry. All samples taken in the framework of the operator's environmental sampling programme are analysed in the laboratory. The typical annual sample throughput is around 2300 samples per year. The RMD also operates a mobile laboratory equipped with a NaI gamma spectrometer and an air sampler.

8.3 Ministry of Environment and Water

The Ministry of Environment and Water exercises its operational responsibilities for monitoring of the 3 – 100 km zone around KNPS through a specialised administration - the EEA – the Environmental Executive Agency. The Laboratory and Analytical Activities Directorate (LAAD) operates the central laboratory of the EEA in Sofia and also co-ordinates the activities of the seven laboratories of the Regional Laboratory of Environment and Waters (RLEW) which are equipped for radiological monitoring.

The EEA Sofia laboratory and the RLEW laboratories at Vratsa and Montana carry out radiation monitoring activities related to KNPS.

8.4 Ministry of Health

The radiation monitoring laboratory system of the Ministry of Health consists of the Public Exposure Monitoring Laboratory (PEML) of the National Centre for Radiobiology and Radiation Protection (NCRRP) together with five regional laboratories of the Regional Inspectorate for the Protection and Control of Public Health (RIPCPH). The NCRRP is responsible for monitoring of national or regional relevance whilst the RIPCPH laboratories are responsible for monitoring of regional relevance only.

Both the Sofia-based PEML and the RIPCPH Vratsa laboratory participate in monitoring of the environmental impact of KNPS.

9 VERIFICATION ACTIVITIES - ENVIRONMENTAL PROGRAMMES

9.1 Introduction

The limited time available for the verification visit did not allow for the verification of the environmental monitoring facilities of the Ministry of Agriculture and Food Supplies.

9.2 The EEA laboratories (Sofia)

9.2.1 *The Bulgarian Radiation Monitoring System*

The verification team visited the central station in Sofia of the BULRAMO (Bulgarian radiation monitoring system) and examined issues common to all 26 of the local BULRAMO stations. However, the Sofia monitoring station itself was not visited, since the team had selected the Oryahovo monitoring station for verification of a representative monitoring station.

EEA personnel presented the operation of the BULRAMO system to the verification team. Measuring stations are concentrated along international frontiers and in the Kozloduy 30 and 100 km zones. BULRAMO has been in operation since 1998. Local monitoring stations are built around Technidata DLM 1440 Control Units, which have provision for connection of up to 15 gamma probes, a weather station, a public display of the measured doserate, as well as for other sensors. As far is is practical, the gamma probes are mounted in a standard way, although in some locations it was necessary to mount stations on building roofs. Each local station can operate for up to 2 days autonomously if needs be. Data is returned to the central station via one of three radio networks. The eastern region is connected to the central station via a dedicated X25 communications line.

Each local monitoring station has provision for monitoring of system parameters and relaying a state-of-health signal to the central monitoring station. (One local station was out of operation at the time of the visit).

Data from BULRAMO is pushed to ministries, agencies, KNPP, and the European Commission's EURDEP system at regular intervals. Several ministries have replicates of the BULRAMO database and the team was able to verify the existence of the replicate held by Bulgarian Civil Protection. In the event of a radiation emergency data pushing frequencies can be increased. Live and archive BULRAMO data can be accessed on a public internet site. The BULRAMO software is run on a Windows 2000 network.

BULRAMO makes provision for transmission of alarms if higher than normal doserates (three times the annual average value) are measured and currently the EEA is working on providing for alerts to staff on a 24/7 basis. Preventive and breakdown maintenance of BULRAMO is performed by a sub-contractor.

The Verification team examined calibration procedures for BULRAMO's gamma probes. Each BULRAMO probe is calibrated every two years by the Bulgarian Metrological Institute (BMI) under contract with the EEA. BMI uses its own sources as well as sources belonging to EEA for the calibration. Each probe is labelled to indicate its calibration status (the labelling of the probe at Oryahovo was confirmed during the visit). Probes are re-checked using the EEA source set when they are re-installed on site. All 26 BULRAMO probes were within their calibration periods during the verification as evidenced by a calibration certificate covering all the probes.

Under the current calibration procedure individual test certificates are not obtained, instead a certificate for the whole group is prepared on demand. The group calibration certificate does not indicate important information such as the certified value of the source used for calibration, the deviation from the certified value of the measurement probe or the measurement uncertainty.

> *It is suggested that the EEA review the calibration procedures for the BULRAMO gamma probes in order to assure consistency with current practices, e.g. as identified in ISO Standard 17025.*

9.2.2 *The EEA Central Laboratory*

The verification team also visited the EEA laboratory in Sofia and discussed the quality management policy of EEA/RLEW and relationship between the EEA laboratory and the RLEW regional laboratories in relation to the annual ERMP of the Ministry of Environment and Water.

The EEA Sofia functions as the methodological leader of this network of laboratories. Data management for the network of laboratories is centralised at the EEA Sofia.

It also carries out on an informal basis parallel analysis of samples measured in RLEW laboratories. The verification team checked the paperwork trail left by one such sample from RLEW Vratsa. The parallel measurements are found to be useful, for example when qualifying new methods or in case of measurement difficulties.

> *The verification team, having noted the utility of intercomparisons between the EEA Central Laboratory and the RLEW laboratories, suggests that these intercomparisons be put on a more formal footing.*

There are a number of sampling points common to the Ministry of Health, KNPS, and EEA. Every year the participants' results are exchanged and compared. The team was able to verify the record of the meeting held in 2006 for this purpose. Since the 2006 meeting, it has been agreed that the Nuclear Regulatory Agency (NRA) will in future also attend the meetings.

Regarding QA, the policy of the network is that all the laboratories of the network operate quality management systems in accordance with ISO Standard 17025 (General Requirements for the Competence of Testing and Calibration Laboratories), although there is no "corporate" QA system since each laboratory operates its own quality system. Several of the Sofia laboratory's analytical methods have been accredited by the Bulgarian Accreditation Service. The laboratory's immediate aim is to achieve accreditation to the 2006 revision of ISO17025. The verification team carried out a spot check of the QA system by examining the audit plan for internal audits as well as the records and follow up of internal audits. No deficiencies were found by this spot check.

The verification team noted recent participation in international intercomparison exercises organised by the IAEA (Seibersdorf and Monaco), BfS (Germany), and COOMET (the Euro-Asian Co-operation of National Metrological Institutions, the secretariat of which is based in Kharkov, Ukraine). The verification team also visited the analytical facilities and examined sample management in the laboratory. The alpha spectrometry, gamma spectrometry, and liquid scintillation laboratories were all visited, although it should be noted that only the liquid scintillation equipment is used for routine samples taken in relation to Kozloduy. The other equipment may be used for parallel analyses as described above, for example for parallel measurements of filters from air samplers.

- **Laboratory equipment**

Gamma spectrometry

Three gamma detectors are available for gamma measurements:

- Gamma-1 is an HPGe 30 pc detector (Canberra).
- Gamma-2 is a Ge 40 pc detector with a beryllium window (Canberra).
- Gamma-3 is an HPGe 30 pc detector with a beryllium window (Silena).

The laboratory uses Genie 2000 software, including the quality control package.

On a weekly basis, the energies of the Cs-137 and Co-60 peaks, and the resolution of the Co-60 peak are checked. The background is verified once per month and a full calibration is performed every three years.

Alpha spectrometry

For total alpha measurements the laboratory uses a FAG alpha counter (multi low level counter FHT 770 T). Calibration is carried out daily. The laboratory uses also a second identical counter manufactured by Thermoscientific. Alpha total is performed on ground water and surface water. The team verified the control charts for the energy calibration and the certificates for the calibration sources.

Liquid scintillation spectrometry

The laboratory is equipped with a Quantulus Wallac 1220 liquid scintillation spectrometer, which can be used for low level beta and alpha measurements. Regarding the monitoring programme for Kozloduy, the instrument is used for measurements of tritium.

- **Sample storage room**

The verification team also visited the sample storage room and discussed sample receipt procedures. Samples are stored for at least six months after analysis.

Verification activities with respect to the laboratory facilities do not give rise to any particular remarks.

9.3 The RLEW laboratory (Vratsa)

The RLEW laboratory at Vratsa was established in 1987, with an initial focus on activities related to supervision of the chemical industry in Vratsa County. As well as samples taken by its own staff, the laboratory also routinely measures water samples taken by the staff of the RLEW Montana. The laboratory has 4 specialisations: air, water, radiation dose, and soil. Around 70 samples per year from the MEW's ERMP are analysed there.The verification team visited an air sampling station operated by the Vratsa RLEW. EEA/RLEW operate a total of five such air sampling stations, based upon SEA 270 air sampling equipment, supplied in the mid-1990's under the PHARE assistance programme. At the time of the verification, a call for tenders was underway for replacement of all five sampling stations.

The verification team witnessed a demonstration of the filter changing procedure.The aim is to sample an air volume of 700m³, which takes around seven to ten days depending on the weather. The filters are measured in the Vratsa laboratory and for quality control purposes some are also measured at the EEA Sofia. The Vratsa sampling station operates in tandem with the station operated by the RLEW Montana.

RLEW Vratsa operates a measurement QA system in accordance with ISO17025:2006. Most of the analytical methods applied in the monitoring programme have been accredited by the Bulgarian Accreditation Service. As is the practice within the EEA/RLEW network Vratsa operates its own QA programme. The team examined the QA Manual rapidly and observes that it represents a rather heavy system for a small laboratory such as the Vratsa laboratory.

The team notes that the Vratsa laboratory had participated to the IAEA 2006-03 international inter-comparison exercise for soil, grass, and water using gamma spectrometry.

The verification team also visited the analytical facilities. The equipment for performing beta and gamma measurements was supplied under the PHARE assistance programme in the mid-1990's.

- **Laboratory equipment**

Beta spectrometry

The Verification team visited the beta measurement laboratory to witness the preparation of a water sample for counting.

Total beta is measured following the method of ISO 9697 using an Eberline high-sensitivity alpha-beta counter (multi low level counter FHT 770 T). The instrument is calibrated every 3 years. Once a month, efficiency and peak position are checked using certified Sr-90 and Pu-239. The evolution of parameters relevant to measurement quality is followed by means of control charts.

Gamma spectrometry

The gamma station is an HPGe 30% coaxial detector without beryllium window, from Silena. There is also a twelve position tray. The laboratory uses the Genie 2000 software package for gamma measurements.

Verification activities with respect to measurements do not give rise to any particular remarks.

9.4 Verification activities at the sampling and monitoring locations around KNPS

The verification team selected a number of environmental sampling locations operated by KNPS, MH and the MoEW in the vicinity of KNPS to visit and examine sample taking procedures and the question of the representativity of samples. The opportunity was also taken to visit environmental sample taking facilities operated by the National Institute for Meteorology and Hydrology (NIMH), although these facilities are not part of the NRMP under routine conditions.

The team also met with municipality officials charged with operating gamma monitoring equipment for civil protection purposes. Again this equipment is not a component of the national programme for monitoring environmental radioactivity under routine conditions.

9.4.1 *Sampling and monitoring by the KNPS*

- **Type A sampling and monitoring station**

The first location visited was a KNPS Type A sampling location identified as point A9 and situated on a former co-operative farm 3km from the Romanian border. The location is no longer cultivated. KNPS personnel provided information upon the installed sampling equipment and demonstrated procedures for taking samples of soil, vegetation, and wet-dry deposition. The location for soil and vegetation sampling is clearly signed. The wet-dry deposition sampler is located within a fenced area to prevent tampering with the equipment. Filters are changed on a monthly basis. The team also examined sample administration procedures including sample taking records, and sample identification.

The team also examined the air sampling station, which is installed in a concrete block house. Filters are changed weekly and the sampled air volume is around $80m^3$. The verification team requested and received a valid calibration certificate for the air sampler's flow-meter.

Whenever, samples are taken at Type A or Type B sampling points a measurement is also made of the ambient doserate using a hand-held gamma probe. The team verified that the probe used was within its calibration period.

Sampling point A9 also includes a dairy producer located in a nearby village where the team witnessed taking of a milk sample. Milk from three different villages is handled in this plant.

Verification activities with respect to the KNPS Type A sampling location A9 do not give rise to any particular remarks.

- **Other sampling locations**

The verification team witnessed catching of fish samples from the Danube in the vicinity of the channels linking KNPS to the Danube. The aim is to catch at least 2 kg of fish, preferably carniverous fish. The meat is prepared for analysis of its Cs-137 content and the bones are prepared for analysis of their Sr-90 content.

The verification team also witnessed sampling of river water and bottom sediment from the Danube near the port of Oryahovo (sampling point C-2). For sediments the aim is to sample from parts of the river which are calm. KNPS have surface water and sediment sampling points located both upstream and downstream of KNPS. The river water samples are taken using a batometer, a device which permits sampling at pre-set depths. Sediment samples are taken near the river bank using a core-sampler. The verification team also rapidly visited the nearby sampling point identifed as A10.

The verification team discussed sampling of drinking water with KNPS. All drinking water within the 12 km zone is supplied from five aquifers. The KNPS ERMP includes provision for sampling from all five of these aquifers.

- **AISARC (Automatic Information System for Ambient Radiation Control)**

The verification team verified the operation of AISARC first by a visit to its control centre followed by a visit to one of the system's 8 automatic stations for continuous monitoring of dose rate and the volumetric activity of I-131. The system includes two base stations on site and three weather stations. For emergency purposes an airborne probe is available for vertical profiling of release plumes.

The system was first conceived for use in radiological emergencies, but subsequently in 1999 it was connected to the national automated system for continuous doserate monitoring. The low doserate channel measures doserates from 80 nSv/h upwards. In terms of its emergency functions, the lowest alarm level is set at 300 nSv/h.

All stations are connected to the central station by wireless or cable. In 2006 an additional back-up wireless channel was added. A UPS provides for four hours autonomy. Measurement data is backed up locally and remotely. Copies of the measurement archive are stored in two separate locations.

The originally supplied gamma probes have been replaced by Russian (low doserate channels) and Belorussian ones (high doserate channel) which were found to be better able to resist very low temperatures.

The verification team also visited AISARC station number 4. The station is housed in a steel cabin to protect the electronics from the elements. The station includes sampling and detection equipment for measuring I-131 in an emergency situation.

The performance of the probes is verified annually, *in situ*, by the Bulgarian Metrological Institute.

Under the current calibration procedure individual test certificates are not obtained, instead a certificate for the whole group is prepared on demand. The group calibration certificate does not indicate important information such as the certified value of the source used for calibration, or the individual deviation from the certified value.

> *It is suggested that KNPS review the calibration procedures for the AISARC gamma probes in order to assure consistency with currently accepted good practices, e.g. as identified in the ISO Standard 17025.*

The AISARC probes are calibrated at the same time.

> *It is suggested that KNPS assess the implications for the availability of AISARC during calibration.*

9.4.2 *Sampling and monitoring by the EEA and the Ministry of Health*

The verification team witnessed demonstrations of river water and river sediment sample taking at the EEA's sampling points at Orjahovo. The Ministry of Health also maintains a sample taking location at Orjahovo where the team witnessed a demonstration of soil sampling.

9.4.3 *Sampling and monitoring by the National Institute for Meteorology and Hydrology*

The verification team visited NIMH's sampling facilities at Orjahovo where samples of wet and dry deposition from the atmosphere are taken. The dry deposition samples represent six days accumulation on a 0,3 m² filter, which is analysed by low level gamma spectrometry at NIMH's Pleven laboratory. The MDA for the filters is of the order of 0,1 mBq/m² of Cs-137 and it is several years since values above the MDA have been measured. The collectors for wet deposition are emptied once a month and are analysed using the gamma spectrometer at Pleven. A small NIMH weather station is co-located with these sampling points.

9.4.4 *Monitoring by the Ministry of State Policy for Disasters and Accidents*

The verification team visited Orjahovo town hall where it was also shown radiation monitoring equipment belonging to the Ministry of State Policy for Disasters and Accidents (MSPDA). This is part of the national network of 335 municipal and 28 county posts reporting daily to the MPSDA. Although primarily intended as a network for use in an emergency, the results are also used to follow background radiation levels in Bulgaria, and are published daily on the civil protection website.

9.4.5 *The KNPS Radioecological Monitoring Laboratory (RMD)*

The verification team examined the RMD's approach to quality assurance and measurement quality control. KNPS operates a corporate ISO 9001 QA system. Departments and projects operate Quality Programmes within the framework of the corporate QA system. Radiation Monitoring is the subject of one such quality programme. The team noted that the Corporate QA management had carried out the first internal audit of the radiation monitoring programme in 2007. The RMD's Quality Programme is based upon ISO 17025. No analytical methods have yet been accredited, and management's belief is that the appropriate next step is to seek accreditation to ISO 17025, although at the time of the verification the decision had not been taken.

> *The verification team suggests that proceeding with obtaining accreditation in accordance with ISO 17025 would be an appropriate next step.*

The NRA's authorisation for the environmental monitoring programme in force at the time of verification (O-2882/10.01.2004) imposes no requirements regarding the quality management of the EMRP. The NRA had not performed a topical audit addressing quality assurance *per se in respect of the RMD*, although the NRA states that quality assurance is addressed in its other inspection and auditing activities.

> *The verification team suggests when the time comes to renew or revise the NRA authorisation for the environmental monitoring programme, that quality assurance issues be addressed.*

The verification team examined document control at the operational level. The RMD's operating procedures are described in 103 working instructions. These are made available to staff via the KNPS-wide, electronic document management system known as SmartDoc. All users of the KNPS network have access to SmartDoc, which provides access to the latest version all of KNPS's controlled documents. The system is controlled by the Safety and Quality Management Directorate's Department of Document Management.

The verification team also examined the management of samples and measurement results. The complete sample life cycle is managed using the database application known as MOS, which is specific to the RMD. It includes the sample taking plan, preliminary sample preparation, laboratory quality control such as the results of duplicates and blank samples, and control charts, measurement results, and verifies whether measurement results are in line with expectations. It also manages calculation of results, and database queries. The heads of the individual laboratories carry out monthly reviews of the measurement results. The verification team verified data records relating to sampling point C-2.

The verification team considers that the SmartDoc and MOS database applications represent the state of the practice and allow the operator to manage documents and the measurement process well.

Final results, validated by the management of the RMD are submitted to customer departments of KNPS as signed, analysis certificates on paper.

A summary of the results of the KNPS programme is published in the Annual Report of the Kozloduy NPP. The results obtained under the KNPS ERMP are discussed in an annual meeting with the Environment Executive Agency and with the Ministry of Health where the NRA participates as observer. The results of the KNPS ERMP are compared with those of the EEA and the MH, including common samples. The team notes that one item on the agenda is conformity with Commission Recommendation 2000/473/Euratom.

The RMD participates regularly in international measurement intercomparison exercises. The verification team notes that during 2002 – 2006 the RMD participated in 16 intercomparisons relevant to its ERMP organised by the Physikalisch-Technische Bundesanstalt (Germany), the Bundesamt für Strahlenschutz (Germany) and the IAEA.

The verification team takes note of the regular participation in relevant international intercomparison exercises and suggests that KNPS also consider future participation in the intercomparisons organised by the European Commission's Joint Research Centre.

The verification team also examined the day to day quality control applied to measurements in the RMD laboratory. At the first level, the important parameters of each instrument are tested and followed by means of the quality control package included in each instrument's control software. Depending on the instrument, the controls would include background checks, check of the FWHM, check of the energy calibration. The verification team verified the regular performance of the energy calibration check and the FWHM check for the gamma spectrometers.

The second element of internal quality control is based upon instrument calibrations performed every year or every two years depending upon the instrument. The third element of internal quality control is the regular analysis of blank samples (to check that equipment or reagents are not contaminated), duplicate samples as a check on reproducibility of measurements, and of spiked samples (samples containing a determined amount of the analyte).

The verification team takes note of the RMD's thorough programme for measurement quality control.

After a presentation by the staff of the RMD, the verification team visited some of the laboratory facilities. During the visit to the facilities the team witnessed a calcium separation and the separation of strontium from current water samples. The team followed up the relevant administrative paperwork and interfacing with the RMD's LIMS and checked for compliance with KNPS SOPs. The LIMS (Laboratory Information Management System) used in the RMD was developed in-house.

The verification team visited the sample receipt laboratory and discussed procedures for sample receipt. Certificates of calibration for the balances were checked.

- **Laboratory equipment**

Gamma spectrometry

The laboratory is equipped with four gamma detectors:

- A Canberra HPGe–detector GC 4019 with a relative efficiency of 40 % and a FWHM of 1,8 KeV.
- A Canberra HPGe–detector GC 2019 with a relative efficiency of 20 % and a FWHM of 1,9 KeV.
- A Nucleus HPGe–detector with a relative efficiency of 20 % and a FWHM of 2,0 KeV.
- A Ortec HPGe–detector GEM 45 with a relative efficiency of 45 % and a FWHM of 1,8 KeV.

The electronics for the four spectrometers are centralised in a single "Multiport 2" rack.

The gamma spectrometers are controlled using Canberra Genie 2000 (v. 3.0) and its built-in measurement QC package.

Alpha spectrometry

The laboratory is equipped with a Canberra Alpha Analyst system with 8 vacuum chambers, a relative efficiency of 22 % and a FWHM of 20 KeV. The software used for the control of the vacuum and the measurements is Genie 2000 Alpha Analyst v. 1.0. The team verified the use of the control charts generated by the QC package of this software.

Liquid scintillation spectrometry

The laboratory is equipped with three liquid scintillators:

- A LS spectrometer LKB Wallac model Rackbeta-1215.
- A LS spectrometer LKB Wallac model Rackbeta-1219.
- A LS spectrometer LKB Wallac model 1414 Guardian.

9.4.6 *The KNPS Radiochemistry and Concentration Laboratory*

The radiochemistry laboratory was visited. It is well equiped for carrying out the necessary sample concentrations prior to measurement: evaporation for alpha measurements and distillation for tritium measurements. The verification team were given copies of calibration procedures and certificates for the reference sources. The annual throughput of this laboratory is around 2000 samples per year.

In general, the verification team noted that the RMD's laboratory facilities are modern and well equipped with recent measurement equipment. The laboratory management stated that it had no difficulties to recruit and to retain qualified staff.

9.5 The NCRRP laboratory of the Ministry of Health (Sofia)

The verification team visited the Public Exposure Monitoring Laboratory (PEML) of the National Centre for Radiobiology and Radiation Protection (NCRRP) where it addressed the following topics:

- Laboratory regulatory duties (ERMPs)
- Laboratory infrastructure and equipment
- Quality assurance and control
- Reporting

At the same time the team verified the procedures in place with respect to the import of mushrooms from third countries, as required under EU post-Chernobyl regulations: these activities are detailed in section 10 of this report.

<u>Findings and related observations</u>

The team:

(1) Noted that the PEML, a small laboratory with a restricted number of staff, is in charge of a number of separate ERMPs that address:

  - drinking water;
  - foodstuffs (both animal & non-animal) in the Sofia region;
  - wild food products (mushrooms and berries);
  - the Kozloduy power station, the Novi Han waste repository and (former) uranium mining & milling facilities.

  Upon request the team received detailed information (documents) on the above programmes: sampled media, identification of sampling points, frequency of sampling, scope of and type of laboratory analysis, measurement equipment and required MDA.

(2) Noted that one of PEML main duties is the national dose assessment; that this assessment is based solely on the monitoring results of the PEML's monitoring programmes; that the regional laboratories (the RIPCPH) do not communicate their monitoring results to the PEML.

  <u>It is suggested</u> that the Ministry of Health improves the representativeness of its national dose assessment by enforcing and controlling effective and efficient data communication channels from the RIPCPH laboratories to the NCRRP (centralisation of information).

  <u>It is also suggested</u> that the Ministry of Health, in the context of national dose assessment, provides the means to establish a central database for environmental monitoring results. Such a database should normally be operated and managed by the NCRRP.

(3) Noted that the PEML is not equipped with the appropriate measurement devices that would allow it to discharge itself from its statutory responsibility to assess tritium and gross alpha activity in drinking water.

<u>It is suggested</u> that the Ministry of Health, where it imposes a monitoring programme on a laboratory, also provides the laboratory with the appropriate assets to effectively deal with the programme.

(4) Noted that the analytical equipment and processing software present in the PEML, although functional, lack back-up systems or are out of date (for instance: only one gamma spectrometer present, operated with Maestro software; the personal computer processing gamma spectrometry files runs on MS DOS 5; the two single position total beta activity measurement devices date from the late 1960s). This leaves the laboratory vulnerable to possible breakdowns that would be compounded by probable difficulties in obtaining spare parts.

<u>It is suggested</u> that the Ministry of Health, in order to preclude a possible extensive loss of measurement capacity, provides the PEML with the appropriate budgetary means to acquire state-of-the-art equipment in numbers that are in equation with PEML's statutory responsibilities.

(5) Noted that the PEML, although nominated by the Ministry of Health as being a high-level reference laboratory, is not accredited for its analytical methodologies. The verification team however also noted the high degree of professionalism of PEML staff, reflected in the results obtained from regular inter-comparison exercises and proficiency tests.

Was informed that the PEML, due to lack of personnel and means, is not fulfilling its obligations as a reference laboratory. Assistance in quality assurance and/or the organisation of proficiency tests for the 5 Regional Inspectorates is not implemented anymore.

<u>It is suggested</u> that the Ministry of Health, in order to ensure the durability of high levels of quality assurance and control, provides the PEML with those resources it takes to acquire ISO/IEC/EN 17025 accreditation.

<u>It is suggested</u> that the Ministry of Health, in the framework of general quality assurance of its laboratory network, takes the necessary steps to restore and effectively implement the role the laboratory has to play as reference laboratory for the RIPCPH network.

(6) Noted, when considering observation (1) to (4) above, that in case of a radiological emergency occurring, the PEML will fail to effectively deal with the resulting increase in sample numbers.

This weakness jeopardises the radiological emergency response capabilities of the Ministry of Health.

(7) Verified the operational status of the ambient doserate monitor (equipped with large volume proportional counters) present on the premises of the NCRRP: the monitor relays, stores and displays its measurement results (integrated over five minutes) into the laboratory's intranet system. In the event of an alarm the system automatically alerts the desk officer(s) on duty at the Ministry of Health.

(8) Was informed about the Ministry of Health's intention to, somewhere in the future (possibly around the end of 2009), move the NCRRP to modern premises. The verification team welcomes and fully endorses this prospect, especially since it noted the derelict state of the current building that houses the PEML.

<u>Also, the team recommends the NCRRP management</u> to prohibit smoking in the laboratories so as to avoid any interference with the quality of the measurements that tobacco smoke may cause.

9.6 The RIPCPH laboratories of the Ministry of Health (Vratsa / Varna)

The verification team visited the Vratsa and Varna RIPCPH (Regional Inspectorate for the Protection and Control of Public Health) laboratories where it addressed the following topics:

- Laboratory regulatory duties (ERMPs)
- Laboratory infrastructure and equipment
- Quality assurance and control
- Reporting

<u>Findings and related observations</u>

The team noted that:

(1) Both laboratories are very small and equipped with one gamma spectrometer and two single-position total beta counters (measurement devices identical to those at the PEML in Sofia).

(2) Both laboratories, since 1998, implement an ERMP that is limited in its scope when compared to the PEML activities.

(3) Both laboratories have a paper-based bookkeeping that is well organised: sample information, from sample-taking over reception to final measurement result, is easily traceable. This was demonstrated at both labs by a vertical audit of the books for a randomly chosen sample.

(4) The calibration of the gamma-spectrometric devices is performed by the Bulgarian Metrology Institute on a 3-yearly basis. The total beta counters are internally calibrated on a yearly basis.

(5) A quality assurance system based on controlled SOPs is not in place. However, when taking into account the size of the labs and the restricted number of samples that are handled, this is not perceived as a shortcoming, except where it concerns maintenance of the gamma-spectrometric devices. It was noted that detector quality assurance lacked a systematic control of detector efficiency and resolution; the frequency of background checks was not well defined either.

In this context, please also refer to point (5), second paragraph, of section 8.4 above.

<u>It is suggested</u> that the Ministry of Health requires its RIPCPH laboratories to put in place SOPs to properly manage the quality assurance and control of gamma-spectrometric measurement systems.

(6) A yearly ERMP report is forwarded to the MH. However, the reporting is subject to reporting thresholds (measurement results do not need to be report if below a defined value); as a consequence the yearly report is basically reduced to a statement about the number of samples taken. Therefore the MH has no direct access to information on the actual levels of radioactivity in the environment.

In this context, please also refer to point (2) under section 8.4 above.

<u>It is suggested</u> that the Ministry of Health removes value thresholds from the reporting obligation it enforces on the RIPCPH laboratories.

(7) ERMP data are partly archived on floppy disks.

<u>It is suggested</u> that the Ministry of Health considers whether it would not be beneficial from a quality assurance point of view, to review the status of the analytical and informatics infrastructure of the RIPCPH (with radiation control departments) and, where necessary, to initiate a modernisation programme.

10 IMPLEMENTATION OF POST-CHERNOBYL EC FOODSTUFF REGULATIONS

Two legislative acts lay down EU Member States' obligations with respect to the import of agricultural products originating in third countries (countries outside the Union) following the Chernobyl accident:

- Council Regulation 90/737/EEC (the application of which was extended by Council Regulation 616/2000/EEC to last until the year 2010). This Regulation defines maximum permitted levels of radio-caesium for a set of well-defined agricultural products imported into the EU from a number of named countries. Bulgaria having accessed to the EU now also partakes in the responsibility to check that imports into the EU (via Bulgaria) are compliant with the Regulation and thus ensure that imported products exceeding 370 Bq/kg (infant food and milk) or 600 Bq/kg (other products) are not placed on the Bulgarian market and hence on the EU market as a whole (release for free circulation).

- In 1999, the Commission adopted a Regulation laying down the detailed rules for the application of 90/737/EEC. These rules, through an evolutive process, culminated in Commission Regulation 1635/2006/EC, in force since November 2006. 1635/2006/EC in particular strengthens the obligations concerning the import of non-cultivated mushrooms (systematic checks for consignments > 10 kg; obligation for the exporter/importer to present valid export certificates) and identifies a restricted number of customs offices ([7]) through which the mushrooms may enter the EU.

Where it concerns domestic produce, Commission Recommendation 2003/274/EC on the protection and the information of the public with regard to exposure resulting from the continued radioactive caesium contamination of certain wild food products, recommends Member States to continue to carry out checks on wild food products, especially where the origin of these foodstuffs lie within areas with known persistent post-Chernobyl contamination. Wild foods that cause continued concern are wild berries, wild mushrooms, game meat (wild boar in particular) and carnivorous lake fish. Member States should inform the population of those areas where these products can potentially exceed the maximum permitted levels, about the health risk involved. The placing on the market of the said wild products is subject to the rulings laid down in 90/737/EEC.

10.1 Responsibilities

Ordinance Nr 10/2002 (State Gazette nr 44/29.04.2002) transposes Council Regulation 90/737/EEC and associated legislation into national law.

Both the Bulgarian Ministry of Health (for non-animal products) and the Ministry of Agriculture and Food Supplies (for animal products) share responsibilities in the implementation of the post-Chernobyl foodstuff regulations and recommendations.

Both ministries, in order to ensure the practical implementation of their responsibilities, have signed formal cooperation agreements with the Bulgarian Customs Agency.

10.1.1 Ministry of Health

Import

The NCRRP at Sofia and the RIPCPH (at Plovdiv, Varna, Burgas, Ruse and Vratsa) have been designated to implement import control under Ordinance Nr. 10/2002 (scope: non-animal products) as further specified in MH ministerial order Nr. RD-09-361/28.07.1998.

The NCRRP laboratory is accredited in accordance with ISO/IEC 17020.

7 For Bulgaria: the maritime ports of Varna and Burgas; the airports of Sofia, Varna and Burgas.

Domestic

The NCRRP and the 5 RIPCPH have put in place a radiological surveillance programme for wild mushrooms and wild fruit. Emphasis is however put on south-west Bulgaria, the region most affected by Chernobyl fallout: west and central Balkans, the Rila, Pirin and Rhodopae Mountains. The surveillance programme specifies the type of mushrooms and fruits to be sampled, the sampling location as well as sampling frequency and sampling period. The samples are analysed for the presence of Cs-137 + Cs-134.

Summarised, this programme (for the year 2007) encompassed:

Control point	Locality	Sample types
Supermarkets	5 in Sofia	Fresh, dry and processed wild mushroom
Outdoors, in the field	4 regions	Fresh wild mushrooms and berries
Processing industry	5 locations	Fresh, dry and frozen wild mushroom and berries

The species of mushrooms that are focussed upon are the: saffron milk cap (*Lactarius deliciosus*), wood hedgehog (*Hydnum repandum*), birch bolete (*Leccinum scabrum*), porcini (*Boletus edulis*), fairy ring mushroom (specifically *Marasmius caryophylleus*), lack chanterelle (*Craterellus cornucopioides*), grey and yellow chanterelle (*Cantharellus tubaeformis*) and golden chanterelle (*Cantharellus aurora*).

Wild fruit samples particularly address: strawberry, raspberry, blueberry, cranberry, blackberry, cornelian berry, blackthorn, hawthorn, rosehip, conifer cones and wild pear. Pine honey is also integral part of the sampling programme.

10.1.2 Ministry of Agriculture and Food Supplies

Import

The National Veterinary Medical Service (NVMS), through its Border Veterinary Inspection Posts (BVIP) of the Regional Veterinary Medical Services (RVMS) , has been designated to implement import control under Ordinance Nr. 10/2002 (scope: animal products) as further specified in MAFS ministerial order Nr. RD-09-545/30.06.2003.

Samples taken are sent to the organisation's Central Laboratory for Veterinary and Sanitary Examinations (CLVSEE) in Sofia for radiological assay. This laboratory is accredited to ISO/IEC 17025.

Domestic

The implementation of Commission Recommendation 2003/274/EC is incorporated in the standard ERMP for foodstuffs of animal origin, as implemented by the CLVSEE. This ERMP, in 2007, addressed the following media:

- livestock ± 70 samples (cattle, pigs, sheep, goats);
- farm-bred birds ± 20 samples (chicken, ducks);
- raw milk ± 115 samples (cows, sheep);
- eggs ± 65 samples (hens, quails);
- farm-bred game ± 25 samples (pheasants);
- rabbits ± 15 samples;
- honey ± 15 samples;
- wild game ± 100 samples (boars, partridges, quails, pheasants);
- wild fish ± 60 samples ([silver]carp, trout, sturgeon).

10.1.3 The Bulgarian Customs Agency

For each consignment with products subject to control and declared for free circulation within the EU, customs notify the competent authorities, depending on the nature of the products: the NCRRP for non-animal, the NVS for animal products.

The competent authority, upon notification, will proceed to sample the consignment under scrutiny, measure the sample to establish whether its radioactivity levels abide by the regulation (decision) and forward the result to customs.

Customs will release the goods in accordance with the decision made by the competent authority: where failure to comply with the maximum permitted levels of radio-caesium is observed, the competent authorities require products to be destroyed or returned to the country of origin.

10.2 Verification activities and findings

The verification team visited the Sofia airport customs office as a designated 'radiological clearance point' for imports into the EU. At this location the NCRRP gave an in-the-field demonstration of the procedures that have been put in place together with the Bulgarian Customs Agency.

Similarly, at the Varna [west] maritime port customs office, the radiological clearance procedures were discussed, but in this case with representatives of the Regional Veterinary Medical Service (RVMS).

10.2.1 Ministry of Health – Sofia airport (imports)

The verification team had the opportunity to witness the administrative and practical procedures for checking a consignment (app. 500 kg) of fresh wild mushrooms (saffron milk caps - *Lactarius deliciosus*) imported from the Former Yugoslav Republic of Macedonia.

<u>At the Sofia airport customs office</u>

The verification team:

- Noted the BIMIS database ([8]) wherein customs feed all relevant data from import notifications. Early notification of an import is a legal obligation on the importer. This early notification allows customs, through checks against the information contained within the database, to be warned whether the imported goods must be subjected to radiological clearance checks. BIMIS gives an alert when a consignment requires special scrutiny. Upon an alert it is customs' responsibility to formally inform the NCRRP about the arrival of a consignment to be sampled and measured.
- Verified that the van containing the consignment had been sealed by customs at the border crossing. The verification team could check the seal numbers against the relevant customs documents.
- Observed that all regulatory import and customs documents related to one single consignment are kept and archived locally under a unique serial number generated by the customs' database.
- Noted that NCRRP staff must validate and countersign all regulatory import and customs documents for every individual consignment that has to be radiologically checked.
- Noted that the consignment's export certificate declared the mushrooms to contain 0.956 ± 0.473 Bq/kg of Cs-137.

[8] BIMIS allows electronic input and processing of customs-related documents and procedures.

- After removal of the seals on the van, witnessed NCRRP staff sampling the consignment by randomly picking mushrooms from the accessible transport crates. Two polythene bags were filled, each to contain app. 0.7 kg of mushrooms. The bags were sealed and labelled so as to ensure traceability.

At the NCRRP laboratory

The verification team:

- Observed the registration procedure for the sample (registered as sample F627).
- Observed the preparation of one of the samples (the other being kept as back-up): weighing (0.562 kg), chopping of the mushrooms and filling into a Marinelli beaker.
- Noted that the gamma spectrometer was an EG&G Ortec with HPGe detector type GEM15190-P (15% efficiency, 1.75 keV resolution and an MDA of 0.03 Bq/kg).
- Observed the measurement procedure: gamma spectrometry for 3000 seconds; archiving of the spectrum with a unique identifier (F627/071126f7). The measurement result indicated an activity concentration for Cs-137 + Cs-134 of 2.3 ± 0.6 Bq/kg.
- Noted that the results were returned to the customs office by fax: the clearance certificate (document number GR122/2007.11.26) also contains the references of regulatory import and customs documents.

Conclusion

The verification team could satisfy itself that, for Sofia airport as EU entry point, infrastructure and procedures are in place that allow implementation of the checks required under Council Regulation 90/737/EEC and Commission Regulation 1635/2006/EC.

10.2.2 Ministry of Agriculture and Food Supplies – Varna [west] maritime port (imports)

At the customs office

The verification team noted that:

- Imports through Varna [west], originating from third countries requesting special attention, are more the exception than the rule.
- Upon a BIMIS alert, it is customs' responsibility to contact the RVMS or the RIPCPH, depending on the nature of the consignment (animal / non-animal), and to request a radiological clearance.
- The procedures to follow are fully understood by customs officers.

At the RVMS offices

The verification team further discussed procedural aspects and learned that:

- Samples are normally sent to Sofia for measurement.
- An agreement exists with the local RIPCPH of the MH: in cases of urgency a sample is transferred from RVMS to RIPCPH for measurement but the responsibility for clearance however remains with MAFS.

Conclusion

The verification team could satisfy itself that, for the Varna maritime port as EU entry point, infrastructure and procedures are in place that allow the implementation of the checks required under Council Regulation 90/737/EEC and Commission Regulation 1635/2006/EC.

10.2.3 Domestic radiological surveillance - 2003/274/EC

- **Ministry of Health**

The MH, through the NCRRP, is implementing a wild mushrooms and wild berries ERMP. The verification team learned that this ERMP is called a 'thematic inspection' that is conducted to confirm whether the products listed for special attention in 2003/274/EC represent a radiological risk and hence may lead to a MH decision to require a future follow-up monitoring programme.

It is suggested that the Ministry of Health, irrespective of the outcome of the 'thematic inspection', sustains its efforts in the radiological monitoring of wild food products.

- **Ministry of Agriculture and Food Supplies**

The MAFS implements, through the CLVSEE, an ERMP focussed on animal products which incorporates the products listed for special attention in 2003/274/EC. However, the team noted that specific monitoring of carnivorous lake fish is not part of the ERMP.

It is suggested that the Ministry of Agriculture and Food Supplies, to be in compliance with Commission Recommendation 2003/274/EC, includes the radiological monitoring of carnivorous lake fish into its environmental radioactivity monitoring programme.

11 CONCLUSIONS

- All verifications that had been planned by the verification team were completed successfully. The team wish to indicate their appreciation of the quality and the comprehensiveness of the information supplied to them before the visit.

- A summary overview of the verification findings and related recommendations will be compiled in the 'Main Findings' document that is addressed to the Bulgarian competent authorities through the Bulgarian Permanent Representative to the European Union.

- The present Technical Report is to be enclosed with the Main Findings.

With respect to the radiological surveillance programmes related to the KNPS

(1) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of radioactive discharges from the KNPS are, in general, adequate. The Commission could verify the operation and efficiency of the facilities visited.

(2) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the KNPS are, in general, adequate. The Commission could verify the operation and efficiency of the facilities visited.

(3) However, in some areas the verification activities revealed room for improvement. These findings lead to recommendations that will be formulated in the Main Findings. These recommendations do not discredit the fact that the radiological surveillance of the KNPS is, in general, in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

With respect to the national radiological surveillance programmes

(4) Within the short time allocated and hence their restricted range, the verification activities demonstrated that the facilities necessary to carry out continuous monitoring of the level of radioactivity in the air, water and soil on the territory of Bulgaria are adequate. The Commission could verify the operation and efficiency of the facilities visited.

(5) However, in some areas the verification activities revealed room for improvement. These findings lead to recommendations that will be formulated in the Main Findings. These recommendations do not discredit the fact that the radiological surveillance of the Bulgarian territory is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

With respect to the national radiological early warning network

(6) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of ambient gamma doserates in Bulgaria are generally adequate. The Commission could verify the operation and efficiency of these facilities.

With respect to the radiological monitoring of foodstuffs under post-Chernobyl legislation

(7) Within the short time allocated and hence their restricted range, the verification activities indicated that infrastructure and procedures are in place that allow the implementation of the checks required under Council Regulation 90/737/EEC and Commission Regulation 1635/2006/EC; as well as under Commission Recommendation 2003/274/EC.

(8) However, the verification activities revealed room for improvement and will lead to recommendations to be formulated in the Main Findings.

Final remarks:

(9) The Commission would be grateful if the competent Bulgarian authorities would keep it abreast of the progress made with respect to the observations and recommendations made in the Main Findings.

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

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APPENDIX 1

RECEIVED DOCUMENTATION

Note: The list does not include various other documents that were asked for (and received) during the verification activities such as calibration certificates, standard operation procedures, quality assurance procedures, source records and measurement results, technical drawings, legislative texts, reports …

Ministry of Economy and Energy

- Explanatory text "Preliminary information on the implementation of the obligations of the Republic of Bulgaria under Article 35 of the EURATOM treaty". Text received as reply to a general questionnaire on Art.35 matters that was submitted to the competent Bulgarian authorities.
- Presentation (slides) titled "Euratom Treaty Article 35 verification mission in Bulgaria 2007 – country report".

Bulgarian Nuclear Regulatory Agency

- Presentation (slides) titled "Euratom Treaty Article 35 verification mission in Bulgaria 2007".
- Operating license for Kozloduy Unit 5. Ref. V-3307 dated 09/08/2007.
- Operating license for Kozloduy Unit 6. Ref. VI-3319 dated 24/10/2007.
- Annual Report 2005

Ministry of Health

- Presentation (slides) titled "Radiation control system of the Ministry of Health".
- Presentation (slides) titled "Implementation in Bulgaria of Council Regulation 737/90/EEC, Commission Regulation 1635/2006/EC and Commission Recommendation 274/2003/EC".
- Explanatory text: "Information on the implementation of the requirements of Regulation 737/90/EEC, Regulation 1635/2006/EC and Recommendation 274/2003/EC".
- Explanatory text on the implementation of the "Thematic Inspection: compliance with the requirements to the content of technogenic radionuclides in wild mushrooms and fruit intended for the internal market and for export".
- Cooperation agreement between the Ministry of Health and the Bulgarian Customs Agency to prevent the import of goods hazardous to the public health. Ref. 16-01-0015/13.10.2003.

Ministry of the Environment and Waters

- Presentation (slides) titled "The Executive Environment Agency in Bulgaria".

Ministry of Agriculture and Food Supply

- Presentation (slides) titled: review of the environmental radioactivity monitoring programmes as implemented by the MAFS laboratories having competence in the matter.
- Cooperation agreement between the National Veterinary Service of the MAFS and the Bulgarian Customs Agency to raise the effectiveness of border control. Ref. 4604/24 12.12.2006.

Ministry of State Policy for Disasters and Accidents

- Presentation (slides) titled "Verifications under the terms of Article 35 of the Euratom Treaty".
- Presentation (slides) titled "Kozloduy NPP plc – general presentation".

Kozloduy NPP

- Presentation (slides) titled "Environmental radiation monitoring – Kozloduy NPP"
- Presentation (slides) titled "Radiation Monitoring of Gaseous and Liquid Releases from Kozloduy NPP Facilities".
- Annual Report 2006.

Bulgarian Customs Agency

- Presentation (slides) titled "Customs control in the framework of Regulation 737/90 and Regulation 1635/2006".

Consulted web sites

- Ministry of Economy and Energy www.mee.government.bg
- Nuclear Regulatory Agency www.bnra.bg
- Ministry of Health www.mh.government.bg
- National Centre for Radiobiology and Radiation Protection www.ncrrp.org
- Ministry of Environment and Waters www.moew.government.bg
- Executive Environment Agency http://nfp-bg.eionet.eu.int/ncesd/eng/index.html
- Ministry of Agriculture and Food Supply www.mzh.government.bg
- Ministry on State Policy for Disasters and Accidents www.mdpba.government.bg
- Kozloduy NPP www.kznpp.org

Other sources consulted

European Commission, DG SANCO: Country profile of Bulgaria on food and feed safety, animal health, animal welfare and plant health – FVO Report 11590 April 2007.

APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY OVERVIEW

Team-1: S. Van der Stricht + Å. Wiklund.
Team-2: F. MacLean + P. Vallet + A. Ryan.
Team-3: S. Van der Stricht + P. Vallet.

Monday 26/11 - Sofia

1. Opening meeting at the Ministry of Economy and Energy:
   - introduction of participating delegations,
   - information presentations
   - finalisation of the working programme.
2. Team-1: verification activities at the NCRRP Public Exposure Monitoring Laboratory.
3. Team-1: verification activities at the Sofia airport Customs Office.
4. Team-2: verification activities at the EEA LMS Central Station + local monitoring devices.

Tuesday 27 and Wednesday 28/11 - Kozloduy

5. Team 1: verification of the monitoring/sampling systems for airborne discharges.
6. Team 1: verification of the monitoring/sampling systems for liquid discharges.
7. Team 1: verification activities at the operator's radiation protection operations control rooms as well as the analytical laboratories for discharge samples.
8. Team 2: verification of a representative selection, within the 30 km perimeter, of the site-related provisions for environmental monitoring/sampling put in place by the operator, the EEA, the NCRRP and the NCPS.

9 Team-2: verification of the operator’s analytical laboratories for environmental samples.

Thursday 29/11 - Vratsa

10. Team-1: verification activities at the RIPCPH laboratory.
11. Team-2: verification activities at the EEA regional laboratory.

Friday 30/11 - Sofia

12. Closing meeting at the Ministry of Economy and Energy:
    - Presentation of the preliminary verification findings,
    - Discussions.
13. Team-3: Meeting on post-Chernobyl foodstuff regulations with the Ministries of Health and of Agriculture and Food Supplies as well as the Bulgarian Customs Agency.

Monday 3/12 - Varna

14. Team-3: verification activities at the Varna maritime port Customs Office.
15. Team-3: verification activities at the RIPCPH laboratory.

APPENDIX 3

LEGISLATION

1. BULGARIAN LAW

1.1 Legislative acts regulating environmental radioactivity monitoring

1. Environmental Protection Act (SG nr 91/25.09.2002; in force since 01.03.2006)
2. Clean Air Act (SG nr 45/28.05.1996)
3. Regulation on the terms and conditions for carrying out Environmental Impact Assessments (SG nr 25/18.03.2003)
4. Regulation on the set up, operation and development of the National Automated System for continuous monitoring of the radiation background in the Republic of Bulgaria (DCM nr 434/19.11.1997)
5. Regulation on the limit values for admissible contents of dangerous and harmful substances in the waste water discharged in the water bodies Promulgated (SG nr 97/28.11.2000)
6. Regulation on the quality of water intended for human consumption (SG nr 30/28.03.2001)
7. Regulation on the quality requirements to surface waters intended for human consumption (SG nr 63/28.06.2002)
8. Regulation on the indicators and limits for the quality assessment of fluent surface waters (SG nr 96/12.12.1986)
9. Regulation on the exploration, use and protection of groundwater (SG nr 57/14.07.2000, as amended in SG nr 64/04.08.2000)
10. **Regulation on the limits for radiation protection and safety purposes in the mitigation of the consequences from the uranium mining industry in the Republic of Bulgaria** (SG nr 101/23.11.1999)
11. Regulation for the conditions and procedure for establishing of special-statutory areas around nuclear facilities and facilities with sources of ionizing radiation (SG nr 69/06.08.2004)

1.2 Legislative acts establishing the responsibilities of the actors

12. Act on the safe use of nuclear energy (SG nr 63/28.06.2002)
13. Disaster protection Act (SG nr 102/19.12.2006)
14. Health Act (SG nr 70/10.08.2005)
15. Energy Act (SG nr 107/09.12.2003)
16. Measurements Act (SG nr 46/07.05.2002)
17. Regulation on basic norms for radiation protection (SG nr 73/20.08.2004)
18. Regulation for radiation protection during activities with sources of ionizing radiation (SG nr 74/24.08.2004)
19. Regulation on the conditions and the procedure for carrying out individual dose control of persons working with sources of ionizing radiations (SG nr 91/07.11.2005)
20. Regulation on ensuring the safety of nuclear power plants (SG nr 66/30.07.2004)
21. Regulation on safety during decommissioning of nuclear facilities (SG nr 73/20.08.2004)
22. Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (SG nr 71/13.08.2004)
23. Regulation on the health norms and requirements in case of work in ionizing radiation environment (SG nr 78/30.09.2005)
24. Regulation on the conditions and procedures for registration, handling and storage of data, contained in the register of the persons who work or worked in ionizing radiation environments (SG nr 76/20.09.2005)
25. Decree on the organization and coordination of European Union issues (SG nr 35/27.04.2007)
26. Regulation on the conditions and procedures for medical insurance and on individual's health protection norms in case of radiation accident (SG nr 84/17.10.2006)
27. Regulation on the content, structure, conditions and procedures for submission of information, foreseen in the European Communities legislation in the field of energy, to European Community institutions (SG nr 106/27.12.2006)

1.3 Legislative acts regulating the radiological surveillance of foodstuffs

28. Foods Act (SG nr 90/15.10.1999)
29. Forestry Act (SG nr 125/29.12.1997)
30. Plants Protection Act (SG nr 91/10.10.1997)
31. Regulation on the maximum permissible radioactive contamination during the import of agricultural production following the accident at the Chernobyl Nuclear Power Station (SG nr 44/29.04.2002)
32. Regulation on the types of foods, which may be processed with ionizing radiations and the conditions and procedures for their processing (SG nr 38/12.04.2002)
33. Regulation on the requirements for bottled natural mineral, spring and table waters intended for human consumption (SG nr 68/03.08.2004)
34. Regulation on the conditions and procedures for food sampling (SG nr 93/21.10.2003)

1.4 Others

35. Convention on the Environmental Impact Assessment in trans-border context of the UN, ratified by the Republic of Bulgaria in 1995 (SG nr 28/28.03.1995)

2. PRINCIPAL EUROPEAN LEGISLATION IN THE AREA OF RADIATION PROTECTION

(full detail on http://ec.europa.eu/energy/nuclear/radioprotection/legislation_en.htm)

1. Council Decision 87/600/Euratom of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency (OJ L-371, 30.12.1987)
2. Council Regulation 87/3954/Euratom of 22 December 1987 laying down maximum permitted levels of radioactive contamination of foodstuffs and of feeding stuffs following a nuclear accident or any other case of radiological emergency (OJ L-371, 30.12.1987) – amended by Council Regulation 89/2218/Euratom of 18 July 1989 (OJ L-211, 27.07.89)
3. Commission Regulation 89/944/Euratom of 12 April 1989 laying down maximum permitted levels of radioactive contamination in minor foodstuffs following a nuclear accident or any other case of radiological emergency (OJ L-101, 13.04.1989)
4. Council Regulation 89/2219/EEC of 18 July 1989 on the special conditions for exporting foodstuffs and feeding stuffs following a nuclear accident or any other case of radiological emergency (OJ L-211, 22.07.1989)
5. Council Directive 89/618/Euratom of 27 November 1989 on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency (OJ L-357, 07.12.1989)
6. Commission Recommendation 90/143/Euratom of 21 February 1990 on the protection of the public against indoor exposure to radon (OJ L-80, 27.03.1990)
7. Council Regulation 90/737/EEC 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 (OJ L-082, 29.03.1990) – as amended by Council Regulation 2000/616/EC (OJ L-75, 24.03.2000)
8. Commission Regulation 90/770/Euratom of 29 March 1990 laying down maximum permitted levels of radioactive contamination of feeding stuffs following a nuclear accident or any other case of radiological emergency (OJ L-083, 30.03.1990)
9. Council Directive 90/641/Euratom of 4 December 1990 on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas (OJ L-349, 13.12.1990)
10. 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, 29.06.1996)
11. Council Directive 97/43/Euratom of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466/Euratom (OJ L-180, 09.07.1997)

12. Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole (OJ L-191 of 27.07.2000)
13. Commission Regulation 2001/1621/EC of 8 August 2001 amending Regulation (EC) 1661/1999 as regards the export certificate required for agricultural products and the list of customs offices permitting the declaration of products for free circulation in the Community (OJ L-215, 09.08.2001)
14. Commission Recommendation 2001/928/Euratom of 20 December 2001 on the protection of the public against exposure to radon in drinking water supplies (OJ L-344, 28/12/2001)
15. Commission Recommendation 2003/274/EC of 14 April 2003 on the protection and information of the public with regard to exposure resulting from the continued radioactive caesium contamination of certain wild food products as a consequence of the accident at the Chernobyl nuclear power station (OJ L-99, 17.4.2003)
16. Council Directive 2003/122/Euratom of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources (OJ L-346, 13.12.2003)
17. Commission Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation (OJ L-2, 06.01.2004)
18. Commission Regulation 1635/2006/EC of 6 November 2006 laying down detailed rules for the application of Council Regulation (EEC) 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power-station (OJ L-306, 7.11.2006)

3. IAEA AND ICRP GUIDANCE DOCUMENTS

1. Fundamental Safety Principles, IAEA Safety Standards Series nr SF-1
2. Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series nr GS-G-2.1
3. Environmental and Source Monitoring for Purposes of Radiation Protection Safety Guide, IAEA Safety Standards Series nr RS-G-1.8
4. Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants Safety Guide, IAEA Safety Standards Series nr NS-G-2.7
5. Preparedness and Response for a Nuclear or Radiological Emergency Safety Requirements, IAEA Safety Standards Series nr GS-R-2
6. Regulatory Control of Radioactive Discharges to the Environment Safety Guide, IAEA Safety Standards Series nr WS-G-2.3
7. International Basic Safety Standards for protection against ionizing radiation and for the safety of radiation sources, IAEA Safety Series nr SS 115
8. Recommendation of the International Committee on Radiation Protection - ICRP (Publication 60)

APPENDIX 4

KNPS - RADIOACTIVE DISCHARGES - ANALYTICAL LABORATORIES

1. EQUIPMENT

1.1 EP-1 – RCH Section Laboratory

Gamma spectrometry	CANBERRA gamma spectrometer, 1 unit, GeHP detector 20% relative efficiency and 1.8 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
	CANBERRA gamma spectrometer, 1 unit, GeHP detector 25% relative efficiency and 1.9 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
Low background radiometry	Low Background alpha-beta counting system “MINI20”; 4 measurement gas flow proportional counters and two guard counters, Ar/CH_4 gas.

1.2 EP-2 - RCH Section Laboratory

Gamma spectrometry	CANBERRA gamma spectrometer, 1 unit, GeHP detector 20% relative efficiency and 1.8 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
	CANBERRA gamma spectrometer, 1 unit, GeHP detector 30% relative efficiency and 1.9 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
Low background radiometry	Low Background alpha-beta counting system “MINI20”; 4 measurement gas flow proportional counters and two guard counters, Ar/CH_4 gas.

1.3 EP-2 – ORDC Section Laboratory

Gamma spectrometry	CANBERRA gamma spectrometer GC-4019, 1 unit, GeHP detector 40% relative efficiency and 1.8 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
	CANBERRA gamma spectrometer GC-5019, 1 unit, GeHP detector 50% relative efficiency and 1.9 KeV FWHM at 1332.5 KeV of Co-60, Genie 2000 software.
Low background radiometry	Low Background alpha-beta counting system FHT 770T (1 unit), gas flow proportional detectors.
	Low Background alpha-beta counting system FHT 1100 (2 units), scintillation detectors.
Total beta counter	ECM 21, Geiger-Mueller counter (1 unit).

Determination of Strontium, alpha emitters and Tritium is performed in the RM Department.

2. QUALITY ASSURANCE AND CONTROL

2.1 Quality controlled documentation

Quality assurance at KNPS is, *inter alia*, managed through a comprehensive document control system. All documents, such as SOPs and related working sheets, are centrally stored in an electronic database called "SmartDoc". Whenever necessary, staff can download the documents from their workstations.

The documents regulating the monitoring of gaseous and liquid releases to the environment are the following:

- Documents requiring prior approval by the NRA because part of the licensing conditions: radiation protection instructions, technical specifications, operational conditions, etc.
- Documents related to the implementation of regulatory requirements such as, for instance, "Monitoring programmes for gaseous and liquid releases to the environment during normal operation of the KNPS".
- Organizational documents that regulate the interaction between the sections/departments of the KNPS that are responsible for the discharge monitoring (example: "Guidelines on the organization of the Radiation Monitoring of liquid releases from Units 5, 6 and AB-3" and "Instructions for the utilization of the information from AISRMWW").
- Prescriptive SOPs detailing the operative implementation of tasks: working instructions and methodologies. These also include aspects of QA/QC such as the maintenance and calibration of instrumentation.

All documents must be approved (version control) and validated (signature of those in charge) before release in SmartDoc.

2.2 Laboratory instrument quality controls

Laboratory instrument quality controls are summarised in the following table:

Gamma spectrometry systems	Background measurements	At least monthly
	Energy calibration control Co-57, Co-60 and Cs-137 test sources	At least weekly
	Control of the resolution (FWHM)	At least weekly
	Control of the relative efficiency of the detectors Co-60 test source at 25 cm distance	At least quarterly
	Control of the reproducibility of the efficiency calibration	At least monthly
Alpha-beta measurements	Background measurements	At least monthly
	System stability and system efficiency	At least twice a year
	Plateau test (optimum operational high voltage)	Annually

3. DATA MANAGEMENT

Recording – sample identification	- date of sampling (or sampling period) - plant item identifier (tank or stack) - information written on SOP - information saved in spreadsheets
Recording – laboratory measurement	- generated result files saved on HD - measurement results: on paper (source documents + reports) + saved in database
Archives	- paper: originals kept in lab - digital carriers (disquettes, CD etc.) - SQL server

APPENDIX 5

THE KOZLODUY NPS ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

Monitored environmental media	Number of monitoring points	Sampling frequency	Number of samples and measurements per year	Monitored parameter	Measurement range and key nuclides	Analytical and measurements methods					Regulations
						LBD TLD	HPGe γ-sp.	LB R	LSC	RCh Sr/Cs	
Gamma radiation-background 5active control)	1 9+3+1 23+14 23	daily weekly monthly semi annual	$\approx$ 240 $\approx$ 660 444 138	Dose rate, (H*10) LBD	50 nSv/h$\div$10 mSv/h 20 KeV $\div$ 7 MeV 100 nSv/h$\div$10 Sv/h 45 KeV $\div$ 1.3 MeV	X	-	-	-	-	BNRP-2004
Gamma radiation-background (passive control)	22+10 + 30	Quarterly	128 + 120	Dose and (H*10) TLD ($CaSO_4$:Dy)	Energy range > 25 KeV	X	-	-	-	-	BNRP-2004
Air (aerosols)	10 1	Weekly monthly	532 + 120	Total beta		-	-	X	-	-	-
				Gamma emitters	Cs-137, Co-60/Be-7	-	X	-	-	-	BNRP-2004
Atmospheric deposition	33	Monthly	396 + 56	Total beta		-	-	X	-	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	-
				Gamma emitters	Cs-137, Co-60/Be-7	-	X	-	-	-	-
Surface waters	3 1 3	Weekly semi annual annually	41	Total beta		-	-	X	-	-	Regulation 7/1986
				H-3 activity	H-3	-	-	-	X	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	-
				Gamma emitters	Cs-137, Co-60	-	X	-	-	X	-
Drinking water	5	Monthly	60	Total beta		-	-	X	-	-	Regulation 9/2001
				H-3 activity	H-3	-	-	-	X	-	Regulation 9/2001
				Sr-90 activity	Sr-90	-	-	X	-	X	BNRP-2004
				Gamma emitters	Cs-137, Co-60	-	X	-	-	X	BNRP-2004
Ground waters	12 26 77	Monthly every second month quarterly	144 156 308	Total beta		-	-	X	-	-	-
				H-3 activity	H-3	-	-	-	X	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	-
				Gamma emitters	Cs-137, Co-60	-	X	-	-	X	-

LBD – low background dosimetry
TLD – thermo luminescent dosimetry
HPGe γ-sp. – gamma spectrometry
LBR – low background radiometry
LSC – Liquid scintillation counting
RCh Sr/Cs – radiochemical separation of Sr and Cs

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Monitored environmental media	Number of monitoring points	Sampling frequency	Number of samples and measurements per year	Monitored parameter	Measurement range and key nuclides	Analytical and measurements methods					Regulations
						LBD TLD	HPGe γ-sp.	LB R	LSC	RCh Sr/Cs	
Waste waters	5	Monthly	60	H-3 activity	H-3	-	-	-	X	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	-
				Gamma emitters	Cs-137, Co-60	-	X	-	-	X	-
Sediments (natural water bodies)	1 3 3	Quarterly semi-annual annually	13	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
				Gamma emitters	Cs-137, Co-60	-	X	-	-	-	
Sediments (waste and sewage discharges)	6 1	Semi-annual annually	13	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
				Gamma emitters	Cs-137, Co-60	-	X	-	-	-	
Soil	37	Semi-annual	74 + 5	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
Vegetation	3 9	Quarterly semi-annual	12 18	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	
Algae (natural water bodies)	7	Annually	7	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	
Algae (waste and sewage discharges))	7	Annually	7	Sr-90 activity	Sr-90	-	-	X	-	X	App. 7, art.129, Regulation on IRS, 2004
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	
Fodder and cereals	4	Annually	16 - 32	Total beta		-	-	X	-	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	Regulation 22/1994
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	Regulation 22/1994
Milk (cow)	3	Monthly	36 + 12	Total beta		-	-	X	-	-	-
				Sr-90 activity	Sr-90	-	-	X	-	X	Regulation 22/1994
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	Regulation 10/2002
Fish (BPS - Danube river)	2	Monthly (on catch)	24 + 24	Sr-90 activity	Sr-90	-	-	X	-	X	Regulation 22/1994
				Gamma emitters	Cs-137/K-40	-	X	-	-	-	Regulation 10/2002