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Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

URANIUM SITES

Environmental Radioactivity and Discharge Monitoring

BULGARIA

10 to 14 August 2009

Reference: BG-09/07

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Uranium mining and milling sites: Provisions for monitoring and controlling of radioactive discharges and for the surveillance of the environmental radioactivity in the vicinity of the sites.
DATE:	10 to 14 August 2009
REFERENCE:	BG-09/07
VERIFICATION TEAM:	Mr C. GITZINGER (Head of team) Mr E. HENRICH Mrs. A. GODEANU-METZ
DATE OF REPORT:	26 May 2010
SIGNATURES:	

[signed]	*[signed]*	*[signed]*
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1 ABBREVIATIONS

AA	Agricultural Academy
AC	Advisory Council
ALARA	As Low As Reasonably Achievable
ASUNE	Act on the Safe Use of Nuclear Energy
AUTC	Ammonium Uranium-Three-Carbonate ($NH_4UO_2(CO_3)_3$
BASEA	Bulgarian Accreditation Service Executive Agency
BDS	Bulgarian State Standard
BNRP-2004	Basic Norms on Radiation Protection, updated in 2004
BULRAMO	Bulgarian Radiation Monitoring network
CFS	Coagulant-Flocculant-Sorbent
CLVSIE-MAF	Central Laboratory for Veterinary and Sanitary Investigation and Ecology (of MAF)
CMD	Council of Minister's Decree
CMS	Controlling and Measuring System
DG ENER	Directorate General for Energy (of EC)
DG JRC – IES	Directorate General Joint Research Centre – Institute for Environment and Sustainability (of EC)
DGNSCP-MES	Directorate General "National service for civil protection" (of MES)
DG TREN	(former) Directorate General for Energy and Transport (of EC)
DLC	direct-flow leaching columns with ion exchange resins
EC	European Commission
EEA	Environmental Executive Agency
EIA	Environmental Impact Assessment
EMD-MOEW	Environmental Monitoring Directorate of MOEW
ERA	Emergency and Rescue Activities
EURDEP	EUropean Radiological Data Exchange Platform
FRPIR	Facility for Regeneration Purification of Ion-Exchange Resins
HEAP	Hydro Ecological expertise, Assessment and Prognosis
HEF	Hydroecological Examinations and Forecasts
HPGe	High Purity Germanium (gamma radiation detector device)
IAEA	International Atomic Energy Agency
ICR	Inventory Change Report
ICRP	International Commission on Radiological Protection
IRMM	Institute for Reference Materials and Measurements (of EC DG JRC)
ISL	In Situ Leaching
ISPUCMW	Installation for Sorption Purification of Uranium Contaminated Mine Waters
KNPS	Kozloduy Nuclear Power Station
LAAD-MOEW-(EEA)	Laboratory and Analytical Activities Directorate of MOEW

LASRM	Local Automated System for Radiation Monitoring
LRRR-MAF	Laboratory for Radioecology and Radioisotope Research (of MAF)
MAF	Ministry of Agriculture and Food
MEE	Ministry of Economy and Energy
MES	Ministry of Emergency Situations
MF	Ministry of Finance
MH	Ministry of Health
MOEW	Ministry Of Environment and Water
MP	Monitoring Point
NCRRP	National Center for Radiology and Radiation Protection
NGB	Natural Gamma Background
NPP	Nuclear Power Plant
NRA	Nuclear Regulatory Agency
NRB	Natural Radiation Background
NSEM-MOEW	National System of Environmental Monitoring (of MOEW-EEA)
OJ	Official Journal
OW	Observation Well
PEML-NCRRP	Public Exposure Monitoring Laboratory (NCRRP of MH)
PIL	Physical inventory listing
RAS	Radioactive Substances
RCD	Radiation Control Departments
REF	Radioecological Examinations and Forecasts
REAP	Radio Ecologic expertise, Assessment and Prognosis
RIEW	Regional Inspectorate of Environment and Water
RIPHPC	Regional Inspectorates for Public Health Protection and Control
RLEW-MOEW	Regional Laboratories for the Environment and Waters (of MOEW)
RM	Radio ecologic Monitoring
SERAW	State Enterprise Radioactive Waste
SFSF	Spent Fuel Storage Facility at Kozloduy
SG	State Gazette
SHC	State Health Control
SIR	Sources of Ionizing Radiation
SW	Surface Waters
TDA	Technology Damaged Area
TBR	Technical and Biological Remediation
WHO	World Health Organization
WWTP	Waste Water Treatment Plant
XML	eXtensible Markup Language (Information Technology)

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 (DG ENER), and in particular its Radiation Protection Unit (ENER D4), 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 (if applicable), terrestrial and aquatic environment around the site, for all relevant pathways.
- Levels of environmental radioactivity on the territory of the Member State.

From 10 to 14 August 2009, a verification team from DG ENER (former DG TREN) visited different uranium mining and milling sites around *Sofia* (central), as well as in south-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 these sites 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 different mining and milling sites and the corresponding environmental radioactivity monitoring, the EC team was accompanied by representatives of the Ministry of Economy and Energy. The team also visited the dosimetry laboratory (*DIAL* Ltd.) at *Buhovo*.

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, in the premises of the Ministry of Economy and Energy at *Sofia*.

The present report contains the results of the verification team's review of relevant aspects of discharge control and radiological environmental surveillance put in place by the competent Bulgarian authorities on and around the verified uranium mining and milling sites.

[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).

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/CG/cd D(2009)49114, dated 29 April 2009.

Subsequently, practical arrangements for the implementation of the verification were made with the Bulgarian competent authorities, which provided preliminary information on the Bulgarian legislation and its implementation with respect to radiation protection for (former) uranium mining and milling sites.

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

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 and of the environmental radioactivity monitoring programmes as carried out for the visited uranium mining and milling sites (sampling and monitoring systems, analytical methods, quality assurance, bookkeeping, reporting).

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 verifications were carried out in accordance with the programme, an overview of which is attached as Appendix 1 to this report.

3.2.1 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 questions from the Commission. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 2 as well as the web sites used. 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.

3.3 REPRESENTATIVES OF THE COMPETENT AUTHORITIES AND THE SITE-OPERATORS

During the verification visit, the following representatives of the national authorities and the site-operators were met:

Ministry of Economy and Energy (MEE):

- Hristo Kazandzhiev – director of Natural resources and concessions directorate
- Petar Petrov – state expert, Restructuration and liquidation unit
- Anri Donchev – interpreter

Ministry of Health (MH):

- Res.Ass. Viktor Badulin – NCRRP deputy director
- Res.Ass. Kremena Ivanova – Head of Inspectorate for the Control of Nuclear Facilities within NCRRP

Ministry of Agriculture and Food Supply (MAF):

- Dr. Jordanka Hristozova – Agriculture Academy
- Assoc. Prof. Dr. Maia Poinarova – N. Pushkarov Soil Science Institute
- Assoc. Prof. Dr. Ivanka Yordanova – N. Pushkarov Soil Science Institute

Nuclear Regulatory Agency (NRA):

- Lilyana Dobreva – head of Operating control of SIR unit

Ministry of Environment and Waters- Environmental Executive Agency (MOEW-EEA):

- Mihail Shishenkov – head of Radiological Measurements Laboratory unit, Directorate General Laboratory and Analytical Activities, EEA
- Hristina Halatchliyska – head of Ionizing radiations unit, Environmental Monitoring directorate, EEA

"*Ecoengineering RM* Ltd.":

- Vasil Tchanev – manager of "Ecoengineering RM Ltd."
- Atanas Metchenov – head of technical activities
- Ditchko Dikov – specialist monitoring activities

***DIAL Ltd.*:**

- Ilko Mladenov – project manager
- Temenuzhka Nedyalkova – head of *Ecolab* laboratory

4 LEGISLATION AND COMPETENT AUTHORITIES

4.1 LEGAL BASIS

4.1.1 List of legislative acts regulating the environmental monitoring

1. Environmental Protection Act (*SG 91/ 25.09.2002*)
2. Water Act (*SG 67 / 27.07.1999*)
3. Act on the protection of agricultural lands (*SG 35 / 24.04. 1996)*
4. Council of Ministers' Decree (CMD) № 74/27.03.1998 on the liquidation of the consequences from the extraction and processing of uranium raw materials (*SG 39/07.04.1998 amm. No. 48/2000 г. and No. 78/2005).*
5. **Regulation № 1 on the limit values for the purposes of radiation protection and safety during liquidation of the consequences of the uranium industry in the Republic of Bulgaria** (*SG No. 101 / 23. 11. 1999.)*
6. Regulation on the conditions and the procedure for carrying out environmental impact assessment of investment proposals for construction, activities and technologies. (*SG, No.25/18.03.2003, amm. SG, No.3/10.01.2006)*
7. Regulation № 6 on the Limit Values for Admissible Contents of Dangerous and Harmful Substances in the Waste Water Discharged in the Water Bodies (*SG, No. 97 / 28.11. 2000)*
8. Regulation № 9 on the Quality of Water Intended for Human Consumption (*SG, No*. 30/ 28.03. 2001)
9. Regulation № 12 от 2002 г. on the quality requirements to surface waters intended for human consumption (*SG No. 63 of 28.06.2002*)
10. Regulation № 7 on the indicators and limits for the quality assessment of surface waters (*SG No.96 / 12.12.1986*)

11. Regulation № 1 on the exploration, use and protection of groundwater (*SG No. 87 of 30. 10.2007*)
12. Regulation № 18 on the quality of water for irrigation of agriculture crops (*SG, No. 43 of 9.06. 2009.*)
13. Regulation № 25 on the requirements for the protection of persons from chronic exposure resulting from the production, trade and use of raw materials, products and goods with increased content of radionuclides (*SG, No. 64 of 5.08.2005*)

4.1.1.1 List of legislative acts establishing the responsibilities of the authorities in this matter

1. Act on the safe use of nuclear energy (*SG No. 63 of 28.06.2002*)
2. Health Act (*SG No. 70/ 10.08.2005*)
3. Energy Act (*SG No. 107 om 9.12.2003*)
4. Measurements Act (*SG No. 46 / 7.05.2002*)
5. Regulation on basic norms for radiation protection (*SG No. 73 / 20.08.2004*)
6. Regulation for radiation protection during activities with sources of ionizing radiation (*SG No. 74 / 24.08.2004*)
7. Regulation No.32 on the conditions and the procedure for carrying out individual dose control of persons working with sources of ionizing radiations (*SG No. 91 / 07.11.2005*)
8. Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (*SG No. 71 / 13.08.2004*)
9. Regulation No.29 of 16 September 2005 on the health norms and requirements in case of work in ionizing radiation environment (*SG No. 78 / 30.09.2005*)
10. Regulation No. 28 of 9 September 2005 on the conditions and procedures for registration, handling and storage of data, contained in the register of the persons who work or have been working in an ionizing radiations environment (*SG No.76 / 20.09.2005*)
11. CMD № 85/17.04.2007г., on the organization and coordination of the European Union issues (*SG. No.35 of 27.04.2007*)
12. Regulation № 28 on the conditions and procedures for medical ensurance and on individual's health protection norms in case of a radiation accident (*SG No.84/2006*)

"FOOD" (Ministry MAF)
The control of the radionuclide content in non-animal origin products is defined by Order No. РД 09-744/22.10.2003 of the Minister of Agriculture and Foods.

4.1.2 International legislation and guidelines, on which the environmental monitoring is based

1. Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1
2. Environmental and Source Monitoring for Purposes of Radiation Protection Safety Guide, IAEA Safety Standards Series No. RS-G-1.8
3. Regulatory Control of Radioactive Discharges to the Environment Safety Guide, IAEA Safety Standards Series No. WS-G-2.3
4. International Basic Safety Standards for protection against ionizing radiation and for the safety of radiation sources, IAEA Safety Series No SS 115
5. 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)
6. IAEA Safety Reports Series No. 33: Radiation Protection against Radon in Workplaces other than mines, Int. Atomic Energy Agency, 2003.
7. IAEA Safety Standards, Safety Guide No. RS-G-1.8: Environmental and Source Monitoring for Purposes of Rad. Protection, 2005.
8. ICRP Recommendation 60: Annals of the ICRP, 1991.
9. ICRP 2007 Recommendation, approved version, March 2007.
10. World Health Organization: Indoor Air Quality: A Risk-Based Approach to the Health Criteria for Radon Indoors, WHO, 1993. different publications and recommendations of the

German Radiation Protection Commission SSK (in particular Publication No. 47) and of the German Federal Office for Radiological Protection
11. ICRP Pubication 101: Assessing dose of the representative person for the purpose of radiation protection of the public and the optimisation of radiological protection,
12. ICRP Publication 78: Individual monitoring for the Internal Exposure of Workers, 1998.
13. ICRP Publication 74: Conversion coefficients for use in radiation protection against external radiation, 1997
14. ICRP CD1: Database of dose coefficients: workers and members of the public, 2002.
15. ICRP Publication 68: Dose Coefficients for the Intake of Radionuclides by Workers, 1995.
16. ICRP Publication 72: Age-Dependent Doses to the Members of the Public from Intake of Radionuclides – Compilation of Ingestion and Inhalation Coefficients, 1996.
17. ICRP Publication 66: Human Respiratory Tract Model for Radiological Protection, 1994.
18. The 2007 Recommendations of the International Commission on Radiological Protection (ICRP Publication 103)

4.2 COMPETENT AUTHORITIES

A scheme of the ministries and bodies having competence in radiation protection and environmental radiation monitoring, according to the Council of Ministers' Decree CMD № 74 of 1998 is presented in Appendix 3.

4.2.1 Nuclear Regulatory Agency (NRA)

4.2.1.1 Introduction

Nuclear energy and ionizing radiation are used in the Republic of Bulgaria in compliance with the requirements and principles of nuclear safety and radiation protection for the purpose of securing the protection of human life, health and standards of living of the present and future generations, the environment and material consequences from the harmful impact of ionizing radiation. Nuclear energy and nuclear materials are used only for peaceful purposes in accordance with the Act on the safe use of nuclear energy (ASUNE) and the international treaties which have been ratified pursuant to the promulgated constitutional order, and have entered into force for the Republic of Bulgaria.

According to the law on the safe use of nuclear energy, for the use of nuclear energy and ionizing radiation and for the management of radioactive waste and spent fuel:

- Nuclear safety and radiation protection have priority over all the other aspects of this activity;
- The irradiation of the personnel and population with ionizing radiation is maintained at as low as reasonably achievable level (ALARA).

According to Art. 4 of the law on the safe use of nuclear energy, the application of the state regulation on the safe use of nuclear energy and ionizing radiation, as well as the safe management of radioactive waste and spent fuel, is within the responsibilities of the Chairman of the Nuclear Regulatory Agency. He has the status of an independent specialised body of the executive power and his competence is determined by the above mentioned law. Pursuant to Art. 13 of the law on the safe use of nuclear energy, the Ministers of Health, Environment and Waters, Interior, Defence, Agriculture and Food Supply, Transport and Communications and Education and Science, exercise a specialized control in accordance with the powers conferred on them by this law.

4.2.1.2 Organizational structure of the Nuclear Regulatory Agency (see also Appendix 4)

The Chairman of the Nuclear Regulatory Agency (NRA) is assisted by an administration which is structured in the form of an Agency. The structure, activities, organization of work and the number of personnel of this Agency are determined in the Statutes of the NRA. These Statutes are proposed by the Chairman of the NRA, approved by the Council of Ministers and published on the NRA website.

Directorates which carryout licensing and inspection activities are:

- General Department of Safety Regulation of Nuclear Facilities;
- Department of Safety Analyses, Assessment and Research and Development;
- Department of Radiation Protection and Emergency Preparedness.

The Department of Radiation Protection and Emergency Preparedness (staff – 22 persons) assists the Chairman of the Agency in performing his regulatory and control functions related to the sources of ionizing radiation and to the radioactive waste management at facilities using sources of ionizing radiation, including radioactive waste transports to the State Enterprise Radioactive Waste (SERAW) facilities. Besides this, the Directorate assists the Chairman in performing his crisis management functions in case of emergencies at nuclear facilities or at facilities using sources of ionizing radiation.

The following bodies are established within the NRA and function under the direct control of the Chairman:

- Nuclear Safety Advisory Council;
- Radiation Protection Advisory Council.

These Advisory Councils assist the Chairman's activities in giving opinions on nuclear safety and radiation protection scientific issues. Leading scientists and experts in the field of nuclear energy and ionizing radiation are members of these councils. The membership and the Rules of the Advisory Councils' work are determined by the NRA Chairman.

4.2.1.3 Licensing and permission activities of the Nuclear Regulatory Agency

The activities related to the use of sources of ionizing radiation have to be based on licenses or permits for their safe implementation, issued by the Chairman of the NRA. Such permits may cover among others the construction of facilities with sources of ionising radiation; decommissioning; temporary storage of radioactive substances; transport of radioactive substances and import and export of sources of ionising radiation. Issuing of licences covers among other the use of radioactive substances and other sources of ionising radiation for economic, medical or scientific purposes; the manufacture of sources of ionising radiation and the handling of such sources.

4.2.1.4 Inspection activities of the Nuclear Regulatory Agency

The Act on the Safe Use of Nuclear Energy (ASUNE) entrusts the NRA Chairman to implement the control of nuclear safety and radiation protection in the use of nuclear energy and ionizing radiation and in the management of radioactive waste and spent fuel.

This control may consist of:

1. Preventive control – which is implemented during the process of issuing licenses, permits or qualification certificates;
2. Current control on the implementation of the conditions set in the issued licenses, permits or qualification certificates;
3. Follow-up control on the implementation of the recommendations and the prescriptions, given by the controlling authorities.

The NRA Chairman, in implementation of his controlling functions, through duly empowered administrative officers from the NRA (controlling inspectors) may:

- carry out periodic and extraordinary verifications (inspections);
- notify other bodies for specialized control of the measures to be taken related to their competence;
- notify the prosecutor authorities in case of available data relative to a crime;
- amend or repeal a permit, license or qualification certificate issued;
- impose enforcing measures and administrative acts, foreseen in the law on the safe use of nuclear energy.

The NRA Chairman is entitled to require from legal or physical bodies information on their activities, the necessary documents related to the implementation of the control, and – if needed – to require co-operation from the respective control authorities.

The common aim of the regulatory inspections and the implementation of enforcing measures is to ensure the implementation of all activities of the license holder in a safe manner and in compliance with the requirements, norms and rules on nuclear safety and radiation protection. For the implementation of this goal, the activities of regulatory control are included in the annual plan of the NRA.

4.2.2 Ministry of Environment and Waters (MOEW)

4.2.2.1 Introduction

The Ministry of Environment and Water (MOEW) is the principal actor responsible for the monitoring of the environment in Bulgaria.

The state policy for environmental protection is under the responsibility of the Minister of Environment and Waters. This Minister, in coordination with the Minister of Health, the Minister of Regional Development and Public Works, the Minister of Transport, the Minister of Agriculture and Food and the other interested Ministers and heads of state agencies, develops a National Strategy on Environment and submits it for approval by the Council of Ministers. According to the law on environmental protection, state policy is integrated into the transport, energy, building works, agriculture, tourism, industry, education etc policies.

4.2.2.2 Organizational structure

The organizational structure of the Ministry of Environment and Waters is shown in Appendix 5.

In the structure of the Ministry of Environment and Waters are included:

- Environmental Executive Agency (EEA)
- Regional Inspection of Environment and Water (RIEW)
- Basin directorates;
- National parks directorates;

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

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

EMD operates the automated online national gamma dose rate monitoring and early warning network comprising 26 measurement stations known as BULRAMO (Bulgarian Radiation Monitoring network). The BULRAMO network was not part of this verification. The continuous measurements from the BULRAMO network are available, online and in real time to concerned national authorities and to the Kozloduy NPP. They are also downloaded once a day to the European Commission's (public) EURDEP internet site.

The following bodies are established by the Minister of Environment and Waters:

- Higher expert ecology council;
- Advisory councils on the policy for the management of the environmental components.

4.2.2.3 Responsibilities and functions of the Ministry of Environment and Waters

The Minister of Environment and Waters:

- Monitors the state of the environment on the territory of the country;
- Issues orders, permits, instructions and endorses methods;
- Manages the National system of environmental monitoring (NSEM) through the Environmental Executive Agency;
- Issues jointly with the interested executive bodies standards for maximum permissible emissions, for maximum permissible concentrations of harmful substances in environmental media and pathways and for rational use of renewable and non-renewable natural resources, endorses methods for Environmental Impact Assessment (EIA);
- Prepares the annual report on the state of the environment to the Council of Ministers as well as reports on the implementation of the legislative acts of the EU acquis to the European Commission.

4.2.2.3.1 Environmental Executive Agency (EEA) within the Ministry of Environment and Waters

The Environmental Executive Agency (EEA) is an administration which reports to the Minister of Environment and Waters, performing management, coordination and information functions as regards the control and protection of the environment in Bulgaria.

It is also a National reference centre for the European Environment Agency.

The Agency is managed by an Executive director and includes 3 directorates:

- "Environmental Monitoring Directorate" (EMD);
- "Laboratory and analytical activities Directorate" (LAAD);
- "Administrative and legal servicing, financial and economic affairs and ownership management Directorate".

The Agency is entrusted with the guidance of the National System of Environmental Monitoring (NSEM). The "Environmental Monitoring Directorate" (EMD) administers NSEM.

The National System of Environmental Monitoring includes the national monitoring networks for:

- the air in the atmosphere;
- rainfall and surface waters;
- underground and sea waters;
- the geological medium, lands and soils;
- the forests, protected territories and biological diversity;
- depots and old waste contaminations;
- radiological monitoring;
- non-ionizing radiation and noise "pollution" in the environment.

For the purpose of the information procurement of NSEM, a National automated system for environmental monitoring was created, which is organized at national, regional and basin level and which is maintained by the Environmental Executive Agency.

The Laboratory and Analytical Activities Directorate (LAAD) coordinates a laboratory-based national environmental monitoring system consisting of eight laboratories (the central laboratory at *Sofia* and seven regional laboratories). The LAAD environmental radioactivity monitoring programme is developed within the Environmental Executive Agency and approved by the MOEW. 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 MOEW 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 ([2]).

The tasks of the National System of Environmental Monitoring are:

- defining the state of the environment by carrying out a monitoring of the available national networks;
- providing information for operational control;
- processing, analysing, visualisation and storage of the information from the national networks and from EEA's own monitoring;
- forecasting the state, assessing the risk for the environment and development of proposals for improvement;
- creation and maintenance of specialized maps and registers of the environment components and the factors influencing them;
- information procurement of the executive bodies and the public;
- exchange of information on the state of the environment with the European monitoring system.

4.2.2.3.2 Regional Inspectorates of Environment and Waters (RIEW) within the Ministry of Environment and Waters

The Regional Inspectorates of Environment and Waters, the Basin directorates and the National parks directorates ensure the pursuance of the state policy on environmental protection at regional level.

The RIEW directors, the directors of National parks and the directors of the Basin directorates draw up precautionary and ascertainment protocols, issue instructions, orders for implementation of compulsory administrative measures and penal decrees.

The number, territorial scope of activity, functions and structure of RIEW, the powers of their directors and the activity of the National parks directorates and the Basin directorates are determined with rules issued by the Minister of Environment and Waters.

Expert ecology councils are established by RIEW and the Environmental Executive Agency. The functions, tasks, composition, and rules of procedure are determined by the Minister of Environment and Waters.

In case of an emergency or any other type of pollution, when the emission limits for the polluting substance into the environment established by a legislative or administrative act are broken, the persons which committed the infringement and the persons responsible for respecting the limits are obliged to immediately inform the respective district governors, municipality mayors, RIEWs, the Basin directorates and the bodies of the Ministry of Emergency Situations, and in case of a change in the radiation situation, the Nuclear regulatory agency.

The competent authorities are obliged to immediately inform the Ministry of Health and the population concerned about the pollution and to propose measures for the protection of human health and property.

[2] 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)

4.2.3 Ministry of Health (MH)

4.2.3.1 Introduction

The Minister of Health manages the national system of health services and carries out control over the activities concerning citizens' health protection and the State Health Control, thus ensuring a sustainable development of health services in the medical and health institutions as well as in medical specialists' reports.

The state policy for public health protection is carried out by the MH. For the organizational structure of the Ministry of Health see Appendix 6.

The Ministry of Health 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. Both the Ministry of Health and the Ministry of Agriculture and Food share responsibilities in the implementation of Council Regulation (EC) No 733/2008 and associated EU legislation governing the import of agricultural products from third countries into the Community.

4.2.3.2 Responsibilities and functions of the Ministry of Health

The Minister of Health discharges its operational responsibilities in radiation protection through the:

- National Centre for Radiobiology and Radiation Protection (NCRRP), in particular through its Public Exposure Monitoring Laboratory (PEML) 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 five out of 28 RIPCPHs (at *Burgas*, *Plovdiv*, *Ruse*, *Varna* and *Vratsa*).The five regional inspectorates (RIPCPH) with a radiation control department are in charge of:
    - their respective regional environmental monitoring programmes;
    - regional control of all practices involving sources of ionising radiation.

The State Health Control (SHC) for the protection of persons from the impact of ionizing radiation is carried out systematically by the NCRRP and the RIPHPCs, both nominated by the Minister of Health. This control is performed without prior notification, and with set purpose – in case of warnings received from citizens, state and municipality bodies and organizations, and also in case of the availability of other data about what occurred.

Managing authorities (State Health Control bodies) within the Ministry of Health system which are competent in the field of radiation protection and exercising medical and radiation control are:

- The Chief state health inspector;
- Public Health Directorate;
- National Centre for Radiobiology and Radiation Protection (NCRRP);
- Regional Inspections for Public Health Protection and Control (RIPHPC) determined by the Minister of Health.

During the implementation of the State Health Control (SHC) the state health inspectors have the following rights:

- free access to the facilities, products, goods, activities and persons, subject to control;
- to require information and documents and to obtain copies of them on paper or electronic medium;
- to take samples and specimens for laboratory analyses in quantities necessary to carry out testing;
- to order examinations and tests for the assessment of the health status of persons;
- to prescribe suspension from work of persons, who are sick or contagious and represent a danger for the health of the surrounding persons;

- to prescribe implementation of obligatory hygienic and anti-epidemic measures, determining the terms for their implementation;
- to put certifying marks in the respective cases;
- to draw up statements in case of establishment of administrative infringements;
- to draw up proposals for the enforcement of administrative measures, foreseen in the law.

The state bodies, carrying out the monitoring of the radiation parameters of the living environment periodically submit data to the Minister of Health, necessary for the assessment of the health risk.

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

4.2.3.2.1 National Centre of Radiobiology and Radiation Protection (NCRRP) within the Ministry of Health

The National Centre of Radiobiology and Radiation Protection (NCRRP), located at *Sofia*, carries out the state health and radiation control in nuclear facilities of national importance and on sites of the former uranium mining industry in the whole country, as well as of facilities with sources of ionizing radiation on the territory of *Sofia* and the districts of *Sofia*, *Pernik, Kyustendil* and *Blagoevgrad.*

Furthermore the Public Exposure Monitoring Laboratory (PEML), as reference lab, is in charge of performing quality assurance assistance and controls in the five regional inspectorates that operate a radiation control department (and hence perform radiological assays and measurements).

The National Centre of Radiobiology and Radiation Protection (NCRRP) functions as:

- Specialized body of the Ministry of Health regarding its policy for prevention and/or decrease of unfavourable impacts of the sources of ionizing radiation on the health of the population;
- Control body for the compliance with the requirements for the protection of persons from ionizing radiation; in nuclear power plants, research nuclear installations, radioactive waste management facilities and other facilities with sources of ionizing radiation; the radiation factors of the living environment – water, food and goods relevant to the population health;
- Expert body regarding: assessment of the exposure and of the radiation risk for the population and of the occupationally exposed persons; procurement of protection for the patient in case of medical exposure; assessment of the health status of the persons, who are or have been working in an ionizing radiation environment or who have been exposed during a radiation emergency.

The National Centre of Radiobiology and Radiation Protection (NCRRP) is structured in specialized units, in compliance with the main activities in the field of radiobiology, radiation protection, radiation control, medical radiological protection and training and information activities.

National responsibilities within the Centre are allocated to the following teams:

1. Laboratory of the *Inspectorate for the Control of Nuclear Facilities*;
2. Laboratory *Control of irradiated food*;
3. Laboratory *Quality control of radiological equipment*;
4. Laboratory *Metrology of ionizing radiations*;
5. Inspection body 'type A', based on the state accreditation by the Executive agency “Bulgarian accreditation service”;
6. Information and training unit.

The Section for Radiation Control of the NCRRP through the laboratory of the *Inspectorate for the Control of Nuclear Facilities* and the *Public Exposure Monitoring* laboratory organizes the radiological monitoring of the living environment for the purposes of assessing the population exposure as a whole or of groups of it, through:

- Monitoring of the population exposure from natural and increased radiation background and assessment of the radiation risk;

- Analysis of the radioactive substances' content in environmental samples, mainly the artificial and enhanced content of natural radionuclides;
- Control of the content of radioactive substances in consumer goods, relevant for population health (drinking water, food, building materials);
- Monitoring of the radiation gamma-background in *Sofia* (continuous high-precision measurement of the ambient equivalent dose rate on the territory of the NCRRP).

The laboratories are part of the Inspection body 'type A', accredited by the Executive agency "Bulgarian accreditation service"in compliance with BDS EN ISO/IEC 17020:2005.

The laboratory of the *Inspectorate for the Control of Nuclear Facilities* carries out the radiological control of the working environment in facilities, which have obtained an operation license for a nuclear facility by the Nuclear Regulatory Agency, and of the living environment in the vicinity of facilities of the former uranium mining and uranium processing industry in Bulgaria.

The State Health Control (SHC) of the living environment in the vicinity of the facilities of the former uranium mining and uranium processing industry keeps track of the qualitative remediation of the environment in these facilities and of the exposure of the population.

4.2.3.2.2 Regional Inspectorates for Public Health Protection and Control

The Regional Inspectorates for Public Health Protection and Control (RIPHPCs) within the Ministry of Health carry out and organize the implementation of the state health policy on the territory of the respective districts. With the aim to protect the health of the citizens on the territory of the Republic of Bulgaria, State Health Control is carried out for the observance and implementation of the established health requirements in legislative acts concerning facilities for public use, products, goods and activities relevant to human health and the living environment.

The structure and activity of the RIPHPCs are defined by rules issued by the Minister of Health.

The RIPHPCs nominated by the Minister of Health for carrying out state health and radiation control on the territory of the country are:

- RIPHPC *Plovdiv* covering the districts of *Plovdiv, Pazardzhik, Smolyan, Haskovo, Stara Zagora* and *Kardzhali;*
- RIPHPC *Ruse* covering the districts of *Ruse, Targovishte, Veliko Tarnovo, Gabrovo, Silistra* and *Razgrad;*
- RIPHPC *Varna* covering the districts of *Varna, Shumen* and *Dobritch*;
- RIPHPC *Burgas* covering the districts of *Burgas, Yambol* and *Sliven;*
- RIPHPC *Vratsa* covering the districts of *Vratsa, Vidin, Montana, Lovetch* and *Pleven*.

The bodies of the State Health Control (SHC) participate at the expert councils on the territorial arrangement, agree, when needed on the arrangement schemes and plans, participate in the assessment of compliance of investment projects, in commissions on commissioning of buildings, according to the Law on the territorial arrangement and in commissioning of facilities with sources of ionizing radiation, according to the Act on the Safe Use of Nuclear Energy (ASUNE).

The Regional Inspectorates for Public Health Protection and Control establish and maintain a public register of the "facilities for public use", including the facilities with sources of ionizing radiation (SIR) in the country. In case of non-observance of the health requirements in facilities for public use or in case of carrying out activities relevant for the health of the population (including facilities and activities with sources of ionizing radiation), the bodies of the State Health Control may order the cessation of the operation of a given facility or of parts of it, and may also suspend the respective activity until the removal of the infringements.

RIPHPC carries out its activities in continuous relationship and interaction, at regional level, with the other control bodies on the territory of the district.

4.2.4 Ministry of Agriculture and Food (MAF)

4.2.4.1 Introduction

The state policy in areas of agriculture, rural regions, forestry, hunting, fishery and aquaculture is implemented by the Minister of Agriculture and Food. The organizational structure of the MAF can be found in Appendix 7.

4.2.4.2 Responsibilities and functions of the Ministry of Agriculture and Food

The Minister of Agriculture and Food manages and controls veterinary and medical supervision of the breeding of animals, of the reprocessing, import and export of foodstuffs and raw materials of animal origin, of fodder, as well as the introduction of veterinary and medical products. He develops and updates the Ministry's strategy in the field of food safety and prepares programmes for its realization, coordinates and controls the activities of the supervisory bodies to the Ministry on the implementation of the strategy and the programme. He coordinates the Ministry's activity with the Ministry of Health and other institutions involved in food safety.

The Minister, through the *N. Pushkarov* Soil Sciences Institute controls the implementation of the requirements of the Rural Lands Act, soil control and the remediation of the affected and contaminated terrains.

The state control of agricultural production, including it's radionuclide content, is carried out by the bodies acting under the Laws on foods, health, and veterinary medical activity.

The radiological analysis of the samples is performed by two laboratories, carrying out distinct environmental radioactivity monitoring programmes:

- The Laboratory on Radioecology and Radioisotope Research (LRRR) at *N. Pushkarov* Soil Science Institute, which carries out the monitoring of foods of non-animal origin, and
- The Central Laboratory for Veterinary and Sanitary Investigation and Ecology (CLVSIE) of the National Veterinary and Medical Service, which carries out the monitoring of foods of animal origin.

The laboratories are accredited as testing laboratories by the "Bulgarian Accreditation Service" Executive Agency, according to Bulgarian norm BDS EN ISO/IEC 17025.

All measurement results are registered in testing protocols, on the basis of which the state control authorities issue a certificate for the suitability of the production (or trade) in the concerned foods. In case these measuring results point to noncompliance with the regulation №10/2002 requirements for the radionuclide content in foods, or with the temporary limits established by the Minister of Health, the Ministry of Health has to be notified. In case of an infringement, the foodstuffs are withdrawn from the trade network by the state control authorities and are either destroyed or re -exported to their country of origin, at the expense of the last owner.

The Ministry of Agriculture and Food through its Laboratory of Radioecology and Radioisotope Research (LRRR), carries out the monitoring of soils and sediments, according to the Bulgarian State Standard (BDS 17.4.5.01). The sampling is carried out through an established monitoring network for North and South Bulgaria.

4.2.5 Ministry of Emergency Situations (MES)

4.2.5.1 Introduction

The aim that the Ministry of Emergency Situations is pursuing is the establishment of an efficient and effective technically guaranteed and materially integrated system for prevention, training, response and recovery in case of disasters and accidents, which shall correspond to the actual needs of the Bulgarian citizens in such cases.

This aim is to be achieved through development, maintenance and efficient use of resources for prevention, monitoring, timely and adequate response and overcoming of the consequences from crises and other significant negative impacts on the national economy and particularly the critical infrastructure.

4.2.5.2 Responsibilities and functions of the Ministry of Emergency Situations

The main objectives and principles of the state policy for the protection of the population and national economy are:

- Establishment of a single system for protection of the population and the national economy in case of crises;
- Operation of the National emergency telephone system (phone number 112);
- Establishment of a single system for monitoring, early warning, notification and crisis management;
- Prioritized development of programmes and measures for prevention with the purpose of making studies, analyses, forecasts and assessments of the risk factors and dangers for the population, environment and national economy, as well as development of scientifically based solution proposals for raising the degree of their protection and security;
- Allocation of duties for the implementation of the protection measures;
- Prevention of increased risks for the population and the national economy.

The district governors and the mayors bear responsibility for crisis management.

4.2.5.3 Directorate General "National Service for Civil Protection" within the Ministry of Emergency Situations

The Directorate General "National service for civil protection" (DGNSCP) is a specialized administration within the MES with 28 territorial units.

The territorial units of DGNSCP-directorates are established at the administrative centres of the districts, composing the territory of the Republic of Bulgaria.

Within DGNSCP a crisis management centre is established, which is connected with the ministries, institutions, district administrations and the *Emergency and Rescue Activities* Units of the Civil Protection. Through it, in case of emergency situations the coordination and interaction with district administrations and crisis management bodies and forces of the ministries and institutions is provided. At the *Information and Analysis Centre* all the information is gathered, handled, analyzed and distributed in case of a crisis situation and the state and local authorities are kept informed. In a similar way operational communication and information centres are established within the Civil Protection directorates.

A single register of the potentially dangerous facilities is maintained. The data base is updated monthly concerning the presence of dangerous chemical substances and radioactive sources in the facilities and an assessment of the risk for the population and the environment is made.

4.2.6 Ministry of Economy and Energy (MEE)

4.2.6.1 Introduction

The Nuclear facilities in Bulgaria are state-owned. The Ministry of Economy and Energy (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 solid waste management facilities. The corresponding processing and conditioning operations were taken over from KNPS management in 2005; they are performed by this State owned company under a separate license.

In implementation of the Council of Ministers Decree № 74/1998, the Ministry of Economy and Energy supervises and coordinates also the implementation of the working projects on liquidation of the consequences from uranium extraction and processing.

4.2.6.2 Organizational structure and functions

For the organizational structure and the functions of the MEE see Appendix 8.

According to the Constitution and in implementation of the laws' provisions, the Minister of Economy and Energy independently or in co-operation with other authorities and/or public organizations:

- Manages the development of the economy and energy policy and the current activities of the ministry;
- Develops and supervises the implementation of the energy strategy of the country;
- Defines strategic objectives and priorities of the economy and the energy policy within the framework of his power, organizes and coordinates the development of strategies and programs for their achievement;
- Proposes to the Council of Ministers a list of strategic facilities of national importance in the energy sector;
- Makes proposals for the amendment of legislative acts in force or for the adoption of new legislative acts, within the framework of his power;
- Exercises the property rights of the state over the state owned single-property trade enterprises and their management assignment; exercises the state rights as shareholder or as partner in trade enterprises;
- Implements the state policy in the search, exploration, production and efficient use of the energy resources, ferrous and non-ferrous resources– industrial materials; organizes the activities on the granting of permissions for search and/or exploration and on granting concessions for extraction of underground mineral resources and concessions for the construction of hydro-energy facilities; carries out follow-up supervision according to the Law on concessions.

In implementation of the Council of Ministers Decree № 74/1998, the Ministry of Economy and Energy supervises and coordinates the implementation of the working projects on liquidation of the consequences from uranium extraction and processing and coordinates also the interaction with international cooperation programs.

In this context, the Minister of Economy and Energy approves:

- Technical and economical assignments on work projects, feasibility studies and self-monitoring plans;
- Working projects on technical liquidation, technical and biological remediation, water treatment and monitoring of their changes;
- Annual programs and their amendments by facilities, by trimesters and by type of activities, as well as the financial resources necessary for their implementation;

The Minister of Economy and Energy organizes the work of an Advisory Council, involving experts from the Ministry of Environment and Waters, Ministry of Finances, Ministry of Agriculture and Food, Ministry of Health, Ministry of Regional Development and Public Works, State Forestry Agency and Nuclear Regulatory Agency. The Advisory Council discusses and proposes for approval technical and economical assignments, feasibility studies, work projects, self-monitoring plans and work programmes.

4.2.6.3 Natural Resources and Concessions Directorate within MEE

The Natural Resources and Concessions Directorate:

- Participates in the development and implementation of the state policy and strategy on the search, exploration and production of energy, metallic and non-metallic (industrial) mineral resources;

- Participates in the development and implementation of the state policy and strategy in the energy sector concerning energy resources;
- Organizes and participates in the development and approval of projects of legislative and other type of acts related to the prospecting, exploration and production of underground resources (mineral resources) and construction of hydro-energy facilities;
- Prepares projects for updates of the legislative acts in force on technical liquidation and remediation of inefficient production facilities in coal mining, uranium mining and mineral resources extraction;
- Organizes the activities on granting permits for prospecting and/or exploration and concessions for production of energy, metallic and non-metallic (industrial) mineral resources;
- Organizes the activities on granting concession for construction of hydro-energy facilities;
- Organizes and coordinates the implementation, the update and the supervision of programs and projects for prospecting, exploration and extraction of energy, metallic and non-metallic (industrial) mineral resources;
- Organizes and carries out supervision on the implementation of the executed concession agreements and of prospecting and/or exploration of underground resources agreements;
- Organizes and coordinates the development, adoption and supervision of the implementation of programs and projects for technical liquidation and/or remediation of inefficient production facilities in coal mining, uranium mining and mineral resources production;
- Establishes and maintains a departmental register and data base on the permits and concessions granted;
- Participates in the preparation of information and analyses on the production of energy, metallic and non-metallic (industrial) mineral resources at regional and national scale;
- Participates in the preparation, supply and supervision of the state aid use in the coal industry, uranium mining and mineral resources production;
- Plans and checks analytically the incomes and expenditures of the concession activities, permits for prospecting and exploration of underground resources, technical liquidation, remediation and monitoring of facilities for coal mining, uranium mining and mineral resources production.

4.2.6.4 Ecoengineering-RM Ltd.

Ecoengineering-RM Ltd. is a single property company with limited responsibility, 100% state owned by the Ministry of Economy and Energy. It was established according to the Council of Minister's Decree (CMD) No 74 of 27.03.1998 in compliance with the national policy for cessation of the extraction and processing of uranium and liquidation of the consequences at the affected areas. With regard to its organisation see Appendix 9.

The Council of Ministers of the Republic of Bulgaria assigned to *Ecoengineering-RM Ltd.*, *Sofia*, the organization and supervision of the activities on technical liquidation, of technical and biological remediation and implementation of the related activities on water trapment, treatment, embedding and monitoring, as well as all other type of monitoring for the liquidation of the consequences from the exploration, extraction and processing of uranium raw material in the affected areas.

The company carries out its activities on the basis of projects, accounting documentation and programmes, including self-monitoring plans for water, for each facility or activity. The activities of water treatment, embedding and monitoring at the facilities are carried out according to permits issued under the Water Act.

The financing by facilities starts after advice from the Advisory Council, concerning the projects, the accounting documentation and the underlying programmes has been provided to the Minister of Economy and Energy and further to the approval of this ministry. The financing of all activities foreseen in the Council of Ministers' Decree CMD № 74 of 1998 is provided by the State budget. The expenditures and financial reporting on the budget resources foreseen for these activities, is carried out according to the Regulation issued by the Ministry of Finance.

5 URANIUM MINING AND MILLING IN BULGARIA

5.1 INTRODUCTION

Occurrences of uranium ores in Bulgaria were known since 1920. First exploration activities took place in 1935 at the *Buhovo* ore deposit, 25 km from *Sofia*. Serious exploration activities based on technological research and economical calculations were conducted in 1938 and 1939 with the cooperation of German specialists and a first batch of 300 tonnes of uranium ore was mined in 1939 at the *Goten* pit, close to the town of *Buhovo*.

In the period 1946 - 1947 Soviet geologists performed intensive geological investigations of the *Buhovo* ore deposit. At the beginning of 1946 a joint Soviet-Bulgarian enterprise was established but its activity ceased in 1956.

Under the control of the Council of Ministers of Bulgaria the "Rare Metals" Bureau was established. Different exploration methods were applied: geological, geophysical, technological and combined, including aero-gamma-ray-spectrometry, hydro-radiochemical methods and aerial photography.

As a result of these explorations, 39 ore deposits were identified and developed on the territory of Bulgaria.

The main ore deposits for underground extraction are: *Buhovo* near *Sofia*, *Eleshnitsa, Senokos* and *Simitli* in South-West Bulgaria, *Vinishte* and *Smolyanovtsi* in North-West Bulgaria, *Sliven* in Central Bulgaria, *Smolyan, Dospat* and *Selishte* in the *Rhodope* Mountains.

These uranium deposits are of small or medium size (up to 10 000 t), with a uranium concentration of 0.1% and have a complex morphology and are of irregular structure.

Deposits exploited via classical mining methods have a complex geological structure and are situated mainly in mountain regions (*Stara Planina*, *Rhodope* massif, East *Sredna Gora*). The mean surface of the ore beds is between 250 m^2 and 20 000 m^2, occurring at a depth of about 500 m and a low metal concentration. Technical mining conditions and geological parameters lead to high primary costs. Efficiency of the uranium production under these conditions is low.

Under favourable conditions of the ore beds, the ISL method (In Situ Leaching*)* was applied.

In 1969 this methodology was adopted for the first time in Bulgaria mainly for the exploitation of sediment deposits (90%), using drilling systems for leaching and partially in rock deposits through underground systems.

The uranium production followed an ascending rate from 150-200 t per year in the 1950s to 430 t in 1975.

The adoption of the ISL method for uranium production from upper *Thracian* uranium deposits permitted reaching an extraction quantity of 660 t in 1989. At that time 70% of the total quantity of uranium was extracted using this methodology.

Until 1990 16 500 tons of uranium concentrate (U_3O_8) had been mined in the country.

The uranium extraction from the leaching solutions (ISL-method) by ion-exchange resins and their processing had been performed on an industrial scale at the *Zvezda* processing plant near *Eleshnitsa*. Two hydro-metallurgical plants had been built in the town of *Buhovo* and in the village of *Eleshnitsa* for uranium ore processing and production of uranium concentrate ($U_3O_{8;}$ with a concentration of 80-82%).

The extraction and processing of uranium ores in the Republic of Bulgaria ceased, based on three secondary acts of the Council of Ministers Decree (CMD) of the Republic of Bulgaria:

- CMD № 163 of 20 August 1992 on the cessation of uranium extraction activities,
- CMD № 56 of 29 March 1994 on staged cessation of activities and liquidation of the consequences from the extraction and processing of uranium raw materials, and
- CMD № 74 of 27 March 1998 on the liquidation of the consequences from the extraction and processing of uranium raw materials.

The activities foreseen in CMD № 74 of 27 March 1998 on the liquidation of the consequences from the extraction and processing of uranium raw materials in the Republic of Bulgaria are:

- technical liquidation,
- technical and biological remediation,
- purification of uranium contaminated mine waters, and
- environmental monitoring in the regions affected by the uranium extraction.

Upon cessation of mining activities, hydro-ecological and radiological assessments and prognoses were prepared, as pre-project studies, work projects for the technical liquidation, the technical and biological remediation and for water purification and monitoring.

The verification team was informed that the liquidation of the classical uranium and of the geo-technological production sites has been completed. All exits of the classical uranium production mines have been sealed. This means that by now the technical liquidation of all sites mentioned in the Council of Ministers Decrees is completed and the related remediation projects have been accomplished. 1173 ha of agricultural lands have been remediated biologically and returned to their owners after approval by the land property commissions.

5.2 URANIUM MINING AND MILLING SITE ISSUES AND SITE DESCRIPTIONS

The uranium mining (uranium ore production and processing) activities resulted in the environmental contamination of the surroundings of the mining sites, both radioactive and non-radioactive.

5.2.1 Radioactive contamination

During the course of uranium ore processing the major part of the radioactive elements present in the ore (Th-230, Ra-226 and its decay products) is collected in the waste products resulting from the production processes. From these, the most dangerous radionuclide appears to be Ra-226 with 1617 years half-life, decaying down to Rn-222, a gas emitted into the atmosphere from the tailings ponds. The half-life of the latter is 3.8 days. Rn-222 decays to several short-lived products (Po-218, Pb-214, Bi-214, Po-214), to Pb-210 and Po-210, and finally to stable Pb-206. Radon is the key contamination agent of the air and in case of unfavourable climate conditions, lack of vertical circulation and re-distribution in the surface-circulating air, its concentration significantly increases to values exceeding by far the permissible levels.

Radon and the aerosols emitted into the atmosphere as well as the dust rising from the open, non-vegetated portions of the dumps stimulate the mechanical accumulation of radioactive dust in the adjacent agricultural and forest areas and the accumulation of long living and radiotoxic alpha- and beta-active nuclides such as Pb-210, Po-210 and Th-230 in values exceeding the permissible levels.

5.2.2 Non-radioactive contamination

Apart from radioactive nuclides, other waste products resulting from uranium ore production and processing may be detected. These are sulphates (SO_4), carbonates (CO_3) and bicarbonates, nitrites, organic solvents and other reagents stemming from the uranium extraction and processing as well as toxic metals (Fe, Mn, Cu, Zn, Co, Ni, Cr, As, Hg, etc.) from poly-metallic and sulphide-poly-metallic mineralisation accompanying the uranium ores. The well samples from areas of In Situ Leaching, from a number of observation wells in the tailings ponds, from the natural water sources as well as from the gullies of the river grid flowing near the dumps show different concentrations of heavy metals and ion complexes exceeding the permissible levels. The chemical analyses of the waters flowing out from the

mine workings (adits) that contain concentrations of these macro-components directly identify the quality and type of underground waters for each site, and when compared with the general classification of the waters by regions reveal the variations resulting from the mining and uranium mining activities.

5.3 TECHNICAL LIQUIDATION, TECHNICAL AND BIOLOGICAL REMEDIATION (DESCRIPTION AND VERIFICATION ACTIVITIES)

The verification team was informed that the technical liquidation of the uranium mining facilities in the Republic Bulgaria has been completed as described below:

- The activities concerning the technical liquidation of the mining facilities for classical extraction, as well as the one of 18 sorption sites implementing the in situ leaching-method (ISL-method) in the Upper *Thracian* Valley have been accomplished in the period 1992 – 1997.
- The technical liquidation of the uranium processing plant near the town of *Buhovo* has been completed in 2002/2003.
- With the technical liquidation of the *Zvezda* plant near *Eleshnitsa* in 2004 the activities on technical liquidation at the uranium mining facilities within the State Enterprise "Rare metals" have been completely finalized. Radioactively contaminated materials – building waste, scrap etc. have been deposited at the tailings ponds of the *Zvezda* site near *Eleshnitsa* and of the *Metalurg* site near *Buhovo*.
- All activities for Technical and Biological Remediation (TBR) of the *Zvezda* Plant, village of *Eleshnitsa*, are completely finalized. For the implementation of the remediation activities at the *Metalurg* Plant, *Buhovo*, technical projects are developed. The implementation of the remediation activities is forthcoming.
- In the Upper *Thracian* Valley region during the period 1996 – 2001 the biological remediation of 1173 ha of agricultural lands had been completed successfully. They are included in the land regulation plans and have been restored to their former landholders, as agricultural lands. The measured results of the content of radionuclides and toxic elements in analysed samples from these areas are below the maximum permitted levels, which indicate a negligible risk for the population, the flora and the fauna.

The verification team was informed that after 2005 the implementation of the activities under CMD No 74 of 1998 was limited only to activities for technical and biological remediation, monitoring, purification of the mining waters leaking to the surface, regeneration of ion exchange resins, maintenance and guarding of the tailings ponds.

During the verification visit to the *Eleshnitsa* site, which still performs the regeneration of ion exchange resins stemming from the water purification process, the team was informed that there is not yet any solution for the currently stored uranium products ('yellow cake' of 40-45% concentration) resulting from the regeneration process. The intention is to sell this yellow cake to a uranium producing country, but the interest of such countries seems to be low due to the rather low uranium content of this material. At present, the yellow cake belongs to the State (Ministry of Finance).

All the activities regarding the technical liquidation and technical and biological remediation of the uranium mining facilities are based on a prepared Hydro-Ecological expertise, Assessment and Prognosis (HEAP) and a Radio-Ecological expertise, Assessment and Prognosis (REAP) performed in the period 1992 - 1994.

5.4 WATER PURIFICATION AND REGENERATION OF ION EXCHANGE RESINS (DESCRIPTION AND VERIFICATION ACTIVITIES)

The verification team was informed that after the cessation of the activities of uranium extraction and uranium processing the pumping stations for circulating water in the mines were dismantled: this created conditions for the outflow of water contaminated with radionuclides from the stulms. For this

reason mining waters containing radionuclides flowing out to the surface created preconditions for contamination of surface waters in the region of the closed down facilities.

The team was informed that in the regions where these processes were particularly intensive, sorption type treatment facilities have been set up, so called "Installations for sorption purification of uranium contaminated mine waters" (ICPUCMW).

The verification team recommends studying the issue of leachates accumulating inside the mines below the outflow surface, in particular with regard to any contamination of ground water in the very long run, and to consider measures to overcome the highlighted issues.

5.4.1 Installations for sorption purification of uranium contaminated mine waters using ion exchange resins

The operator explained to the verification team that the "installations for sorption purification of uranium contaminated mine waters (ICPUCMW)" are direct-flow leaching columns (DLC) with ion exchange resins and that anionic resins of the type *AMP* or *Varion AP* for multiple uses are used. The technical equipment of the installations permits the processing of waste waters under different climatic conditions and ensures that the parameters of the treatment process are within the limits of the norms for environmental protection, especially concerning the parameter “uranium content”.

A typical design of an installation for the purification of uranium contaminated waters using direct-flow leaching columns with ion exchange resins is provided in Appendix 10.

The verification team was informed that in installations using direct-flow leaching columns, the uranium content in water is monitored at the entry and at the exit. The sampling is done by the operator of these facilities according to a programme approved by the Water Basin directorates responsible for water management in the respective region. The measurements are performed by the *DIAL Ltd.* laboratory on behalf of the operator. The analysis of the resins and of the filtrate for uranium content is carried out by this laboratory which is accredited by the Bulgarian Accreditation Service Executive Agency (BASEA).

The data from the laboratory analyses are supplied by the *DIAL Ltd.* laboratory to the concerned Basin directorates every three months, in compliance with the permit’s conditions. The Water Basin directorates report to the Ministry of Environment and Water. They issue the respective permits for the release of waste waters after treatment, according to Regulation No 10/1999.

The team was informed that the uranium charged (used) resins are transported to the 'Facility for regeneration purification of ion exchange resins' (FRPIR) at the *Zvezda* (hydro-metallurgy) former uranium processing plant, located near the village of *Eleshnitsa* in the municipality of *Razlog* (district of *Blagoevgrad)*, where they are processed.

For the transport of these resins, the Nuclear Regulatory Agency has issued a license.

The verification team visited installations for sorption purification of uranium contaminated mine waters using ion exchange resins situated at:

- the *Chora* site near *Buhovo*,
- the *Iskra* site near the village of *Katina* – municipality of *Novi Iskar*, and
- the *Byalata voda* site, within the municipality of *Kostenets*.

5.4.1.1 *Chora* site

At the *Chora* site, the team was told that currently mine water that pours out to the surface through three boreholes and from the fenced areas No.95 and 127 is pumped up to a reservoir with a capacity of 800 m^3 situated at the surface of a hill above the installation. From this reservoir the water flows to the purifying station by gravity. In the station, two columns with a capacity of 24 m^3 of ion-exchange resin each, are in operation. Bulgarian law states that water having a uranium content of more than

0.3 mg per litre, must be treated. At the entrance of the station, the mining water has a content of 1 mg of uranium per litre. It is purified in the process using ion exchange resins and at the outcome of the station it has a uranium content of 0.03 mg per litre. For controls, a sample of one litre is taken at the inlet channel from the reservoir to the treatment station, as well as at the outlet. The sampling points are labelled.

After one month of treatment, part of the used ion-exchange resin (10 m^3) from one tank is transported to *Eleshnitsa* for its regeneration. A special closed truck is used for resin transport.

Overburden was formerly deposited in the vicinity of the mine; this area has been reconditioned.

The verification does not give rise to specific remarks.

5.4.1.2 Byalata voda site

The *Byalata voda* mining site is situated at 20 km NW from the town of *Kostenets*. From 1977 to 1981 the site was operated by an underground mining method with one shaft and five galleries. From 1981 onward the classic sodium sorption method was applied. After the cessation of the mine operation in 1992 a plant for the sorption purification of mining and drain waters containing uranium was built. These waters are collected by gravity in a 260 m^3 tank. From there the mining waters are pumped to the treatment station which is at a distance of about 800 metres. This water has a uranium concentration of about 1.5 to 2 mg/litre.

The site is fenced in and manned with a guard post. At the mine water purification plant one large column (diameter about 2.5 metres) with a resin volume of ca. 28 m^3 is in operation. Horizontal tanks are used for the storage of regenerated resin before use. After treatment the water has a content of 0.03 mg uranium per litre.

Every six weeks, a part of the uranium charged (used) ion-exchange resin (10 m^3) out of the treatment tank is transported to *Eleshnitsa* for regeneration.

Due to the previous mining activities the wood used for stabilisation in the mine rotted and thus the mining waters now contain organic substances meaning that the used resin from this site has to be regenerated in a slightly different way than is usually done at the *Eleshnitsa* plant.

The verification does not give rise to specific remarks.

5.4.1.3 *Iskra* site

At the *Iskra* site, situated near the town of *Novi Iskar*, the production was stopped a first time in 1960. In 1985, the extraction of uranium was restarted using sulphuric acid. The rocks containing the ore were blasted to fragment the ore. After that the fragmented ore was sprinkled with a sulphuric acid solution. Up to 2000 - 3000 m^3 of sulphuric acid were used per 24 h. While seeping through the rocks, the sulphuric acid leached uranium out of the rocks. Uranium containing solutions were collected in the lowest part of the mine (gallery No 5, especially designed for this purpose) and were pumped out for extraction of uranium using ion-exchange resins (similar to the current water purification method). For the uranium extraction from the solution a sorption plant was built. Following the cessation of mining activities in 1992 the uranium sorption plant was transformed into a purification plant.

Today about 50 m^3 of acidic mining waters (stemming mostly from the rain water seeping through the rocks) are treated per 24 h using a very small column, with a resin volume of 2 m^3. The uranium content of this acidic water (ph 3 to 4) is about 2 mg per litre before treatment. Prior to treatment, the acidity of the water is neutralized by adding limestone powder. The area is not fenced in, but its access is restricted by a barrier and the area is guarded. The whole area has been reclaimed and reforested with locust, a tree that manages very well in difficult environmental conditions. At the water treatment inlet and outlet, once per week samples of one litre each are taken for radiological analyses.

An environmental monitoring programme accepted by the ministries involved forms the basis for these analyses. Ordinance no 10 by the regional directorate for water management specifies minimal requirements for surface waters as well as the sampling points and maximum values for the uranium concentration and for alpha and beta activities. Seventeen heavy metals have to be monitored as well quarterly. Every six months an environmental report is produced and sent to the Basin directorate of the district.

The verification does not give rise to specific remarks.

5.4.2 The Eleshnitsa Site: Facility for Regeneration Purification of Ion Exchange Resins (description and verification)

The 'Facility for regeneration purification of ion exchange resins' (FRPIR) was established on the site of the former *Zvezda* uranium processing plant, in the village of *Eleshnitsa*, belonging to the district of *Blagoevgrad* and was visited by the verification team. The site is completely fenced in and guarded. In the vicinity there are also old uranium mining sites and the tailings ponds used by the site.

This facility is a license holder for the use of radioactive substances for economic purposes, including for the regeneration and purification of ion exchange resins. This licence issued on 18 March 2008 is valid until 18 March 2013.

The uranium recovery plant is additionally fenced in, including a second gate. There is an access control and security guards. In former times the site was an important uranium production site, employing 350 persons (today only 20, including laboratory technicians) where the sorbed uranium was transformed into 'yellow cake' ($NH_4UO_2(CO_3)_3$. From *Eleshnitsa*, the 'yellow cake' was transported to *Buhovo*, where it was transformed into U_3O_8.

After the decision by the Bulgarian government in 1992 to terminate uranium production, the production buildings (grinding, milling, etc.) decayed. Some of the resulting material was sold as scrap, some was buried, some is still on the site.

Today, basically only some administrative buildings and the regeneration building are kept operational. The "regeneration building" is used exclusively for the regeneration of resins stemming from the mining waters purification process at the different former uranium mining sites.

Uranium charged (used) resins from the mining water purification process are transported from the different purification locations in the country by truck to the *Eleshnitsa* site. The verification team witnessed the new *Astra 6441* ("military *Iveco*") truck. It was built by *Officine Mottola SRL*, Triggiano (BA), Italy, and has a maximal transport capacity of 15500 l in two compartments. Upon arrival of the truck, the material (uranium charged resin in aqueous solution) is pumped into a reservoir in the "regeneration shed", using a *Konti Hidroplast* Ø90 PN10 PE80 polyethylene tube.

5.4.2.1 Description of the regeneration process for the ion exchange resins

Technological design

The technological design for the regeneration of ionic sorbents of type *AMP* or *Varion AP* was explained in detail to the team and includes the following operations:

- Washing out of mechanical impurities from the incoming uranium enriched resin – done with a drum with mesh apertures of 0.63 mm, and water outflow of 1 to 2 m^3 per m^3 of sorbent;
- Drainage of the washed resin by an Archimedes screw.
- Entry of the drained (up to 20 to 30% humidity) enriched resin into a batch feeder, filled with 110 g/l of H_2SO_4 solution;
- The real sorbent regeneration is carried out in the direct-flow leaching columns (DLC) with sulphuric acid solution (110 g/l of H_2SO_4) with sorbent consumption up to 10 m^3 and contact time of more than 30 hours. The regeneration column operates with the upper draining device covered by the sorbent, the enriched resin is fed from the top, the regenerating solution from

below; the regenerator passes through the upper draining device, and the regenerated (depleted) resin is collected from the bottom layers of the column;
- Drainage of the depleted resin, return into the transport solution.
- Washing out of the regenerated (depleted) resin from the acid in a DLC column with 1 to 2 m^3 feeding water per m^3 of sorbent;
- Drainage of the washed out depleted resin;
- Inversion of the regenerated sorbent form (acidic) H^+ form into (alcaline) OH^- form, via processing in DLC column with 0.5 to 1 m^3 per m^3 of sorbent with a sodium carbonate solution ($NaCO_3$) – 60 g/l), until alkaline reaction is obtained (pH $\geq$ 7 at the coloumn outflow);
- Drainage of the inverted resin;
- Washing out of the inverted sorbent of Na_2SO_4 with feeding water – 2 m^3 per m^3 sorbent;
- Neutralization of the acid waters with chalk solution $Ca(OH)_2$ in pneumatic shakers until pH = 6 to 8.5;
- Storage of the regenerated and inverted resins before forwarding to the installations for sorption purification of mine waters from uranium.

Liquid/liquid extraction of uranium from solutions

- Extraction of the uranium, stemming from the fluid, from the regenerated substance in a four-chamber direct-flow extractor with organic solutions (0.15 - 0.12 mols) solution of di-2-ethilhexilphosphorous acid and 3-butile phosphate in light diesel fuel (kerosene);
- Re-extraction of the uranium from the enriched organics with an alcaline solution of ammonium bi-carbonate (NH_4HCO_3).

Production of 'yellow cake'

- Separation in a three-phase cone-sediment trap;
- Dehydration of the obtained crystal ammonium uranium-3-carbonate (AUTC) $NH_4UO_2(CO_3)_3$ with a vacuum-filter;
- Packing and storage of the $NH_4UO_2(CO_3)_3$.

Furthermore, some supplementary operations have also to be performed, such as:

- correction of the content of H_2SO_4 and oxide-reduction potential (using potassium permanganate) in the output solution for regeneration;
- preparation of chalk solution with density of 1.12 kg/l of hydrated lime and feeding (1:5);
- strengthening of the basic solution with NH_4HCO_3 (dry) in the buffer for the extraction agent.

At full capacity the parameters of the facility for regeneration and purification of ion exchange resins are as follows:

- Regeneration time 30 h ;
- Maximum capacity of resin 0.5 m^3 per h;
- Regeneration solution consumption 10 m^3 per m^3 of resin;
- Oxidation and reduction tension 500–500 mV;
- Consumption of washing water 1 to 1.5 m^3 per m^3 of resin.

After neutralisation the liquid effluents of the process flow to the tailings storage pond, which is a small pond close to the old reclaimed one where solids settle by natural evaporation.

The verification does not give rise to specific remarks.

5.4.2.2 Control and accountancy of the stored $NH_4UO_2(CO_3)_3$

The team witnessed a special room which is designated for the temporary storage of the obtained ammonium uranium-three-carbonate (AUTC; $NH_4UO_2(CO_3)_3$) ('yellow cake'), complying with the requirements of the legislative acts concerning the storage of dangerous substances.

The storage room is isolated from the other parts of the building, a security door is installed, as well as metal bars on the windows. The room is equipped with movement sensors, connected to the guard's premises. Surveillance cameras are installed in the storage facility and in front of the outer door, linked to monitors in the guard's premises, located in the vicinity of the FRPIR.

The team saw that the ammonium uranium-three-carbonate (AUTC) is stored in old sealed steel barrels with a volume of 200 l formerly used for the transport of uranium to Russia.

A number of empty barrels were stored in a room and 21, filled with 'yellow cake', in the currently used storage room behind the first one. The team was informed that this amount roughly corresponds to 15 tons of material, and that it belongs to the Ministry of Finance. The barrels were sealed by Bulgarian safeguards. The quantities obtained are measured with a scales certified by the state metrological institute. A data log-book is maintained for the measurement and accountancy of the quantities of AUTC. The uranium content for each barrel is determined using a special methodology. Analyses are carried out by an accredited laboratory. Bulgaria only has an authorisation to store 25 tons of yellow-cake on its territory.

In compliance with Art. 3 and Art. 6 of Commission Regulation No. 302/2005 on the Application of EURATOM Safeguards, the information on the quantities of AUTC is submitted to EURATOM in Luxembourg by e-mail at: safeguards-reporting@ec.europa.eu, monthly as an inventory change report (ICR) and yearly as a physical inventory listing (PIL) in the form of an XML-file with electronic signature. The site is inspected by IAEA and EURATOM safeguards inspectors.

5.4.3 Tailings ponds (description and verification)

5.4.3.1 Introduction

The uranium ore production and processing development during the last century made it necessary to construct several tailings ponds. Originally these were built by *SE "Redki metali"*. Nowadays *Ecoengineering-RM Ltd.*, Sofia, is in charge of their management, operation and maintenance.

The verification focussed on the *Buhovo* and *Eleshnitsa* tailings ponds.

5.4.3.2 The Buhovo tailings ponds

The *Buhovo* tailings ponds (the old and the new one) are located east of the town of *Buhovo*, within the territory of the town of *Buhovo* and the village of *Jelyava*, in the district of *Sofia*. The team witnessed that the area is controlled by armed guards with guard dogs to prevent vandalism and unauthorized access, as required by the Ministry of Health. The tailings ponds are of classical design closed by a basic wall (rock-fill) and secondary embankments. There are no clay layers underneath the ponds that would prevent the flow of contaminants to groundwater.

The verification team was informed that the old tailings pond (located in the western part of the site) occupies an area of around 21 ha and that the filling of this pond started in 1956 and was terminated in 1973. The closing wall is 13 m high and the volume around 3 500 000 m^3. The tailings pond was also filled using waste from the steel mill nearby and the lake allowed to dry out naturally. The team witnessed that it is partially reclaimed. No further reclamation is foreseen.

The team was informed that for this old tailings pond, no system is available for monitoring and measurements. Thus no piezometric and geodetic measurements are made for this area.

A new tailings pond of the "valley type" (i.e. using the natural structure of the valley and an additional dam) was constructed in 1962. The construction became necessary because the capacity of the old pond became too small due to increased production and also because tailings from other sites were sent to *Buhovo*. This new facility lies to the East of the old tailings pond. It occupies an area of approximately 40 ha. The team was informed that the use of this tailings pond continued up to the 90ies. The volume of the pond is about 4 200 000 m^3. The 55 m high wall was built using materials from the adjacent clay quarry

From 1993 to 2001 this tailings pond was reconstructed in two stages. The second stage covering the period 2000-2001 was implemented under the European Commission's PHARE Programme (2000-2001), project title: "Reconstruction of Buhovo tailings pond – Stage II" for enforcement of the wall, project code: BG9807-03-01. Following the completion of this second building stage, due to failing pumps and other defaults not remedied by the Contractor (*BUTIMAR Soil company*), the committee responsible for the State Construction Supervision did not issue a commissioning certificate. The team was told that currently there is no permit for the use of this tailings pond.

Due to partial catchment of the *Manastirska* River a lake was formed in the cup of the tailings pond. In the spring of 2006 as a result of intensive snow thawing and continuous precipitation the water level in the lake rose significantly. Due to the poor quality of the drainage system in the closing wall of the pond (leaking joints between some drainage pipes) and due to pump failures , part of the closing wall slid down some metres.

The team witnessed that a ca. ten metre wide and two metre deep canal runs along the East side of the tailings pond with the clear goal to catch waters (rain and others) and to prevent them from flowing into the pond. Upon verification this canal was almost dry and the team was informed that it functions very poorly. A lot of water still infiltrates the tailings pond, forming a small lake at its surface. This water is a major cause of the instability of parts of the closing wall and in the past was the cause of several land slides which pose a potential danger to the stability of the entire pond. The major one - about 20 by 50 metres in size - was witnessed by the team. The land slides are currently monitored by controlling the drainage system of the wall using piezometers and through geodetic measurements.

Daily observations are performed, the water level in the piezometers is recorded each week and twice a year geodetic measurements are conducted. No radiological samples are taken from the tailings ponds. The only water sample for radiological measurements by the operator is taken at the outflow of the pond (uranium concentration: 1.5 mg/litre). In the piezometers only the water level is monitored, (no radionuclide measurements are performed). The team was informed that only if the monitoring shows instability, the criterion being withstanding a 9° - Richter scale - earthquake a new construction for strengthening the wall will be started.

Technical and biological reclamation of the pond is foreseen. The team was told that a solution for stopping the water inflow has to be found first. The costs for remediation are estimated at 20 million Euro.

The team was informed that during operation, before the construction of the tailings ponds mine waters were discharged without treatment, thus contaminating the area (called *'Yana overflow'*, affecting two settlements). The contamination situation has been assessed, however currently no routine samples are taken by the operator at these sites.

The competent ministry has given warnings to the local authorities against using the contaminated area. However, some people use these pieces of land (altogether a few hectares), for agriculture and livestock.

At ministerial level plans exist to excavate the soil, which then would be transferred to the pond. Depending on the criteria possibly 500 000 m^3 of soil would have to be moved; this remedial action is expected to be the largest and last project of the whole remediation process. The team was told that there is some hope to be able to achieve this task within the next five years (depending on the financial situation; the costs are estimated at some 10 million Euro).

Another proposal is to change the use of land. To the team this proposal seems somehow unrealistic taking into account the bad economic situation of the population in the region and the fact that it is not possible to guard off the affected area.

The team was informed that the Ministry of Health can propose to the Ministry of Agriculture and Food to impose mandatory restrictions on the use of the concerned agricultural lands or even to buy the land and move the affected population to other areas, because the use of these lands for agricultural purposes could be a danger to public health.

Regarding the new tailings pond, the verification team encourages all efforts to improve the quality of the dam and to guarantee its stability. Certification of the construction by the concerned authority is also recommended. For the near future the team recommends full remediation of this pond.

Regarding both the old and new tailings ponds the team recommends installing radiological monitoring (e.g. with regard to radon emanation at the site and potential groundwater contamination). Such monitoring would have to be in place for long term surveillance; adequate administrative and financial support would be necessary.

After remediation of both ponds, restrictions on agricultural use of the concerned land should apply: e.g. no deep rooting trees (may destroy upper remediation layer), no deep ploughing, grazing restrictions.

With regard to the 'Yana overflow' the team recommends performing radiological measurements with a view to have a continuous realistic assessment of the situation. The team supports any measures to protect the population of the affected area (e.g. agricultural restrictions). This would have to take into account socio-economic and psychological factors, the extremely long duration of the contamination, the need for long term surveillance and long term financial and administrative aspects.

5.4.3.3 *Eleshnitsa* tailings pond

Located in the West *Rhodope* Mountains, some 4 km from the village of *Eleshnitsa*, in the *Razlog* municipality, this tailings pond occupies a part of the *Vylcho dere* River valley and covers an area of around 35 ha.

The verification team visited the pond and it was explained that construction took place in 1969 through stage-by-stage build-ups. Its final wall height reaches 74 m; the volume is around 6 550 000 m^3. The regular operation of the facility was terminated in 1995.

The *Eleshnitsa* tailings pond was subject to reclamation and re-cultivation. The lake of the tailings pond was dried out and covered with material with increased natural radioactivity taken from the dumps of the production sites. The material was laid and compacted in layers. The thickness of the layer above the former water level is in the range of 1.5 m. Further on, this infill was covered with a 0.5 m thick sterile soil bed. In 2002-2005 the *Eleshnitsa* tailings pond was re-cultivated under the Phare Project "Engineering works for closing uranium mines in *Eleshnitsa* and *Dospat*", project code BG9904-03-01-03. The re-cultivated surface is now covered with grass.

The verification team was given a description of the current (uncontaminated) rain water flow management: in a system of ducts surface water is led to a dyke (a channel in the centre of the valley; at the time of the visit containing a low level of water) then to a concrete pipe that leads via a tunnel to the *Bela Mesta* River.

With regard to measurements the team was informed that a radon emanation monitoring programme with marked measurement points has been proposed and accepted by both, the Ministry of the Environment and the Health Ministry.

In a gully located on the right slope of the mountain near the tailing spill-out, a barrier was erected that forms a lagoon for the deposition of sediments stemming from the Waste-Water Purification Facility and from the Facility for the regeneration and purification of ion-exchange resins (FRPIR). This small pond is still used. The verification team was told that this pond usually is dry (the inflowing water quickly evaporates). However, at the time of the visit due to late rainfalls, the bottom of the pond was covered with liquid and some minor land slides had occurred.

Following the overall reconstruction of the tailings pond a commissioning certificate has been issued.

A measurement and control system is operational for the facility. Daily observations are performed, the water level in the piezometers is recorded each week and twice a year geodetic surveys are conducted. Concrete markers are placed to allow detection of any movement e.g. of the dam separating the lagoon from the remediated pond.

The main dam (located at 850 m above sea level.) was reinforced to be able to withstand the pond pressure.

The team was informed that a purification facility for treating the drainage water was built under a Phare Project. The team witnessed this facility which is located at the foot of the dam, about 100 metres lower than the surface of the remediated tailings pond. It is a water purification station for manganese. The station consists of a modern building comprising modern installations, all financed six years ago under a Phare project (Project No. BG 9904-03-01-02; *Wismut* from Germany was contracted as a supervisor for the project).

Nearby the verification team saw the sampling site for groundwater below the dam.

> *The team recommends maintaining radiological monitoring (e.g. with regard to radon emanation at the site and potential groundwater contamination). Such monitoring would have to be in place for long term surveillance; adequate administrative and financial support would be necessary.*
>
> *Restrictions to agricultural use of the reclaimed pond areas should apply: e.g. no deep rooting trees (may destroy upper remediation layer), no deep ploughing, grazing restrictions.*

5.5 ENVIRONMENTAL RADIOACTIVITY MONITORING OF THE SITES

5.5.1 Introduction

The radiation monitoring activities at the former uranium sites are regulated as per Article 1 of the Council of Ministers Decree (CMD) No 74 of 1998 for the elimination of the consequences resulting from uranium production and processing, and include the following activities covering:

- waters catchment, purification and monitoring, as well as
- other types of monitoring performed in the course of eliminating the consequences resulting from exploration, production and processing of uranium ore.

The radiation monitoring is carried out on technologically damaged terrains, dumps, open mine workings (adits, shafts, etc.) by sampling soil, sediments, waters and air.

Measured radiation parameters are:

- Gamma dose rate at one metre above surface;
- Measurement of surface contamination with alpha- and beta-active radionuclides;
- Measurement of volume specific activity (total alpha and beta);
- Measurement of volume specific activity of radon in the surface atmosphere.

5.5.2 Legal basis

The general requirements to the license and permit holders and the general principles, norms and rules on radiation protection provision, which have to be observed during activities in facilities with Sources of Ionizing Radiation (SIR) are determined by the Law on the Safe Use of Nuclear Energy (LSUNE) and it's secondary legislation.

Radiation protection is assessed through an analysis of:

- External and internal exposure of the personnel and the population, received during activities with SIRs;
- Radioactive contamination of the environment;
- Radiation protection measures and the observance of the limits and rules for radiation protection;
- Probability for radiation accidents and their scale, emergency situations and the protective measures undertaken;
- Preparedness for response in radiation accidents and for the liquidation of their consequences.

Assessment criteria are as follows:

- Radiation impact in using SIRs;
- Maintaining of lower limits than defined in the legislative acts of the external and internal exposure doses for the personnel and the population and at a reasonably achievable low level.

Radiation monitoring provides continuous monitoring and information on the radiation situation in the controlled, supervised, radiation protection and observation zones and on the exposure for the personnel and the population resulting from activities in facilities with SIRs. The monitored radiation quantities, the type, their range and the precision of the radiometric and dosimetric equipment used, the posts monitored and the frequency of the radiation measurements are defined in a radiation monitoring programme. This programme is prepared by the respective license holders.

Radiation monitoring is carried out by a departmental service or by an accredited laboratory.

The radiation monitoring is carried out with technical equipment for:

- Measurement of the equivalent gamma-ray dose-rate at the working places, in the production premises, in the radiation protection and in the monitored zones of the Facility for regeneration and purification of ion-exchange resins (FRPIR);
- Measurement of the level of the surface radioactive contamination of working surfaces, equipment, transport vehicles, individual protective means, the body and the clothes of the personnel;
- Measurement of the volume activity of gases and aerosols in the air of the production premises;
- Measurement of the activity of liquid radioactive effluents;
- Measurement of the radioactive contamination of different components of the environment (air, water, soil, sediments, plants) within the radiation protection and the observation zones;
- Measurement of the equivalent dose-rate, specific activity, radionuclide composition and surface contamination during transport and storage of radioactive substances.

Through monitoring of soil, water, fall-out, vegetation, water flora and fauna and agricultural production; the content of radionuclides and toxic metals is determined.

The radiation monitoring programme is approved by the competent state authorities.

The licenses issued on the use of SIRs in the Facility for regeneration and purification of ion-exchange resins (FRPIR) include specific requirements on the radiation protection provision and on the periodicity and the type of reporting to the Nuclear Regulatory Authority (NRA) on the results from the monitoring.

Quarterly reports with the results of the radiation monitoring on the FRPIR site and of the environment are submitted to the Nuclear Regulatory Authority (NRA). The NRA inspectors analyze and assess the compliance of these data with the legislative requirements, as well as the trends in time.

5.5.3 Monitored parameters

The monitoring covers all environmental components including waters (surface and underground), soil and air:

- Mining waters flowing freely from the tailings ponds, the mine workings and the free-flowing wells in the closed-down uranium production sites;
- Artificial radioactive contaminations relating to uranium ore production and processing with regard to destruction of the sub-surface and the relief, as well as the areas where the dumps are located;
- The technological sites of the sorption complexes (In Situ Leaching - ISL methodology), the tailings ponds and the technogenic dumps (waste rock) as sources of ionizing radiation and exhalation of radon and its short-lived decay products;
- The air as the most dynamic component that depends directly on the atmospheric circulation is subject to analysis regarding the outgoing and incoming air flow at the mouth of the galleries and shafts, as well as the radon exhalation within the mine dumps and tailings ponds.

5.5.4 Monitoring networks and points

Local and regional networks have been elaborated for radiation monitoring during and after termination of the mining activity aimed at identification, surveillance and control of the environment within the uranium production sites.

These monitoring networks and points location schemes comply with the conclusions and evaluations included in the Radioecological Examinations and Forecasts (REF) and the Hydroecological Examinations and Forecasts (HEF).

The location and purpose of the monitoring networks and points are based on the following considerations:

- The sampling, measurement and observation points are located along the most dangerous and critical flows or filtrations of radionuclides and toxic metals contaminated waters from the zones where the surface flows occur close to non-contaminated areas. The observations cover the most effective zones and migration directions along normal faults, permeable and lithological contacts and boundaries, karst zones and surface water channels.
- The soil, dump, spoil heaps and vegetation control points are located in the areas that have been most affected by uranium mining in order to acquire the most complete and reliable information and monitoring on the effectiveness of the re-cultivation operations.
- The radiation monitoring of the air is carried out at points of potential risk of radon and short-lived radon decay products emanation.
- The surveillance networks consist of fixed and labelled sampling and measurement points: mine workings, observation wells, natural flows of underground and surface waters, drainage systems of the additional artificial basins, technological lakes, water intake facilities; comprising in particular points with higher concentrations of dangerous radionuclides and heavy metals in the ore fields and production sites and the catchment zones around the sites.
- The elaboration of the monitoring programmes mandatorily takes into account and prescribes the measurement of the water quantities flowing out of the separate points of the site to the main catchment with a view to introducing a contaminated water management scheme or adopting certain purification procedures.
- The monitoring networks and marked points cover 24 out of the total 46 uranium production sites included in the Council of Ministers Decree No 74 of 1998.

At the ISL sites in addition to the main control points for water (besides surface water) seventy-seven observation wells to monitor the underground water within the mining sites have been drilled.

5.5.5 Radiation monitoring activities

5.5.5.1 "Own" monitoring by Ecoengineering-RM Ltd.

The team was informed that *Ecoengineering-RM Ltd.* performs the surveillance for quality control of waters that fall within the category of the so called "own" monitoring stipulated in the Law on Waters and its implementing instruments.

For this purpose the waters are separated into four groups, according to their origin:

- 1st group: surface water reservoirs (rivers, gullies, channels, technological lakes, etc.),89 monitoring points (MP);
- 2nd group: mining waters (from underground workings, open cast mines and mine dump, drainage waters from tailings ponds' collectors, etc.), 73 MPs;
- 3rd group: waters from Quaternary and other non-producing horizons occurring at a depth of up to 50 m, 62 MPs;
- 4th group: waters in producing horizons and deep wells at depths below 50 m (usually 200-250 m) where the ISL method was applied for enriched solutions as well as waters occurring below the elevation of the last producing horizon in underground mining sites, 54 MPs.

Four radiation parameters (natural uranium, Ra-226, total alpha- and beta-activity) and ten non-radiation parameters (pH, F, SO_4, Fe, Mn, Pb, Cd, Ni, As, Se) are subject to analysis.

The analysis of soil and sediments includes the measurement of five radiation parameters (natural uranium, Ra-226, Th-232, K-40, Pb-210) and 16 non-radiation parameters (pH of water extraction, Fe, Zn, Mn, Pb, Cd, Cr^{3+6+}, As, Cu, Co, total absorbed forms of nitrogen, organic carbon, phosphorus, total absorbed forms of potassium, total content of water-soluble salts).

Radon is measured on a site by site basis where accessible mine galleries are available.

Each year the results from the laboratory analyses of waters by sites are reviewed for identification of trends in changes of the major contaminators.

The approved water monitoring programme for 2009 prescribes that for the high-risk sites the samples should be taken twice a year, for the medium-risk sites – the sampling of the waters should be carried out once per year, and for the low-risk sites – once every two years.

The programme is presented in Appendix 11. The methodology applied for water and soil sampling and some field measurements is given in Appendix 12.

It was explained that the site monitoring programme is implemented by teams of specialists of *Ecoengineering-RM Ltd.* according to a preliminary schedule drawn up for field inspections and sampling of the monitoring points. The field equipment includes three mobile gasoline generators (of 2.8 to 3.6 kW output), three submersible pumps – two of them *Grundfos MP3* with 90 m submersion depth and a flow rate of 2 l/min and one *SQ 3-40* with 60 m submersion depth and a flow rate of 1 l/min.

All laboratory studies and analyses of water, soil and sediment samples taken within the monitoring programme are carried out in a specialized certified laboratory, currently *DIAL Ltd.*.

The analyses are performed on the basis of BDS EN ISO/IES 17025 and relevant legal certificates.

5.5.5.2 DIAL Ltd., dosimetric aero logical engineering laboratory

The verification team verified the laboratory facilities of *DIAL Ltd., dosimetric aero logical engineering laboratory*, located in the town of *Buhovo*. The team was informed that *DIAL Ltd.* was set up in 1956 as a unit within the company *SE-"Redki Metali* mining and processing company*"* for the purpose of monitoring the working environment and the environment in general for the uranium industry sites.

For this, the laboratory has the following certificates, licenses and permits:

1. Certificate of accreditation issued by the Bulgarian Accreditation Service Executive Agency No 000713270 for analysis of:
    - Water, soil, sediments;
    - Construction materials and waste from concrete, gravel, facilities, parts of facilities, metallic materials, technological waste – tailing, cuttings, ion-exchange resins;
    - Foods;
    - Air.

    This accreditation complies with BDS EN ISO/IEC 17025.
2. License, Series R-80315, reg. No 02513 issued by the Nuclear Regulatory Agency (NRA) on 24.11.2008, valid until 24.11.2013 for operation with sources of ionizing radiation.
3. Permit No BC 287 issued by NRA on 24.11.2008, valid until 24.11.2013 for temporary storage of radioactive substances as a result of activities with ionizing radiation or relating to such activity.
4. Certificate BG303/08 system for quality management according to ISO 9001:2008

After the liquidation of uranium mining in 1991, the enterprise became a separate company with an expanded scope of activities. *DIAL Ltd.* performs all work for *Ecoengineering-RM Ltd.*.

DIAL Ltd. performs all work on the basis of an annual call for tenders and of a detailed programme. The laboratory employs 16 persons, including 2 physicists, 2 chemists, 1 environmental specialist; 1 mining engineer, 4-5 lab technicians and sampling staff.

The laboratory handles altogether around 1000 samples per year, including construction material. With regards to usability of material in particular construction material an ordinance by the Ministries of the Environment and Health and the Nuclear Regulatory Agency exists defining activity limits, using an index formula (the corresponding value having to be < 1). Depending on the level, the material may be used for the construction of buildings and roads. This ordinance also covers the issue of the usability of former uranium mining areas.

Samples within the supervision programme for the former mining sites are taken by *DIAL* staff. The radiological analyses as well as analyses of the heavy metal content are performed in this laboratory, which is accredited to ISO 17025:2006 and has ISO 9001:2008 certification.

Sample registration

Upon their arrival at the laboratory, all samples are registered in a laboratory book kept by the head of the laboratory. This registration book starts with a new number for every year. It includes the date, place of sampling, the identification code of the sample, parameters to be measured, the quantity of the sample and other details. The registration book is signed by the head of the laboratory. All documentation related to samples to be analysed is stored electronically and on paper.

There is no electronic data base for the registration process.

Sample preparation

The verification team was shown the equipment used for sample preparation / concentration, grinding, sieving and drying (liquid and solid samples). Sample preparation is done according to Bulgarian and international standards. The procedures were available in the main office of the laboratory. The team witnessed the equipment used e.g. for soil solutions, such as a *Büchi* scrubber model *B-414* and a *Diterm* dryer.

Alpha/Beta measurements

The verification team noted the presence of a *Tesla* low level alpha-beta counting assembly with a *NA6201* measuring chamber and a *NA6201 II* frame with power supply, high voltage supply and timer/scaler using methane as a counting gas.

Gross alpha and gross beta activity is measured (separately) for dried water samples, air filters and soil samples. Measurement data are entered into a logbook together with the number of the planchette. Calculations are performed on a PC. The verification team noted that the (natural radionuclide) calibration sources are of a very even structure.

AAS - atomic absorption spectrometer

The team was shown two *Perkin Elmer 3030* atomic absorption spectrometers, of which one was out of order. These spectrometers are used for the determination of the concentrations of Zn, Cu and Fe and other heavy metals with AAS using acetylene gas. Calibrations are done each day depending on the element to be analysed. The devices are not used very often since the laboratory also has Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) measurement technology available.

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)

The team witnessed an optical emission spectrometer (ICP-OES *Varian Vista-MPX*), which is mainly used for the simultaneous determination of low concentrations of elements such as As, Se, Cd and Sb. Calculations are performed on a PC using *ICP-Expert* software.

The laboratory has a service contract with *Varian* in which it is stated that a requested service has to be performed within a period of maximum four days.

Gamma spectrometry

The laboratory is equipped with a gamma spectrometer based on an HPGe detector (relative efficiency 26.2%, resolution 1.89 keV), shielded with 10 cm Pb, lined with 1 mm Cu and 1 mm Cd. It uses *Canberra InSpector* (desk top version) for spectrum acquisition. All calculations are performed on a PC using *Canberra Genie* software. At the time of the verification, the attached printer was under repair. The laboratory uses three to four geometries, among them 0.5 litre Marinelli beakers.

Calibrations are done every three years, energy checks are performed each day and background measurements every month.

For this device the laboratory has a service contract with *Canberra* in which it is stated that a requested service has to be performed within a maximum of four days.

Power supply in case of electricity failure is guaranteed by a UPS power box 10 (eight hours of autonomy). Liquid nitrogen (LN_2) is supplied by the nearby Steel plant.

Mobile low resolution gamma spectrometry is done with a NaI(Tl) detector and a *Canberra InSpector TM 1000* device*;* the system is mainly used for in-field dosimetry measurements.

Radon measurements

The team was shown that for the measurement of Radon emanation, the laboratory has two measurement techniques. One uses *MÉV NY 402* scintillation chambers (a number of such chambers is available, they are well numbered to avoid confusion) and measurement with a *NP 420 P* single channel analyser (*MÉV*, Pécs, Hungary).

The other technique uses a *Genitron Alpha Guard* portable radon monitor.

The team also saw an old *ALGADE* radon monitor.

Alpha/Beta measurements

The team verified the presence of an *Eberline FHT770S* sample chamber and a *FHT1100* digital ratemeter as alpha/beta measuring device with Ar-Methane as counting gas (*Linde*).

Uranium measurements

Uranium determination in liquid media as well as in prepared soil solutions are performed using a *Varian Cary 50 Scan* UV-Visible spectrometer.

The team noted a label on the device indicating the last calibration (2007).

For field measurements, a portable *Merck Spectroquant Nova 60* is also available.

Various

The team noted also the presence of some other devices such as a pH meter (with Redox potential), several balances (e.g. *Sartorius 1608MP*) and a *Büchi K-355* device for distillation. A *LECO AMA254* Mercury analyzer is available for the detection of heavy metals.

Quality management and data handling

The laboratory has ISO 17025 accreditation e.g. for water samples (U, Ra-226, alpha, beta).

All working procedures, calibration docs, instructions, etc, are stored in specific locations in the office and are available for use by all laboratory staff.

Calibration sources come mainly from the Czech Republic.

The team verified the registration files and checked the calibration of the devices. The lab has both, computer files and paper copies.

Reporting

All reports are written on a PC. The team was informed that all protocols are signed by the head of the laboratory and the person that performed the analysis.

> *The team recommends exploring the usefulness of applying a Laboratory Information Management System (LIMS) for sample registration and data handling tasks with a view to simplifying procedures and to avoid manual input errors. It also recommends having all procedures available at the appropriate workplaces.*

5.6 LABORATORIES OF THE COMPETENT AUTHORITIES

The laboratories of the Competent Authorities, which are involved in the authorities' control programme of the remediation and monitoring of the former uranium mining and milling activities were not included in the present verification; information concerning a verification of parts of these laboratories can be found in the Commission's verification report concerning the *Kozloduy*-NPP.

In 2007 the specialized departments of MOEW-EEA and MH-NCRRP conducted joint sampling and radiological analyses of environmental samples from the *Buhovo* uranium production region.

5.6.1 MOEW - Environmental Executive Agency (EEA)

The verification team was informed that the analytical activity in implementing the radiological monitoring programme and ensuring the collection of the required information on the radiation status of the environment in the regions under surveillance is performed by the Laboratory for Radiation Measurements and Analytical Activity of Directorate General of the Environmental Executive Agency (EEA) of MOEW and by its regional units in the towns of *Burgas, Varna, Vratsa, Montana, Pleven, Plovdiv* and *Stara Zagora*.

This EEA analytical laboratory is accredited by the Bulgarian Accreditation Service Executive Agency in compliance with BDS EN ISO/IEC 17025. The involved laboratories for radiation measurements take part in national and international inter-comparisons and proficiency tests, organized by IAEA and EC (DG JRC – IES and IRMM).

5.6.2 Ministry of Health (MH) – National Centre for radiobiology and radiation protection (NCRRP)

The National Centre for radiobiology and radiation protection (NCRRP), Radiation control Section, within the Ministry of Health has two laboratories, namely the Public Exposure Monitoring Laboratory (PEML) and the Inspectorate for the Control of Nuclear Facilities including Regional Inspectorates for the Protection and Control of Public Health (RIPCPH), in particular the Radiation Control Departments (RCD) in five out of 28 RIPCPHs (at *Burgas, Plovdiv, Ruse, Varna* and *Vratsa*) that are in charge of analysing radiation parameters of the living environment aimed at assessing the radiation exposure of the population.

The verification team was informed that NCRRP carries out the specialized radiation control on the parameters of the living environment in the regions covering the former mining sites including the former uranium ore processing sites according to a schedule approved by the Minister of Health Order No RD-15-2688 of 9 September 1998. For the purposes of the specialized control, the programme classifies the sites into three groups:

- regions of high,
- medium and
- low radiation risk.

The programme also specifies the points, frequency, sites and controlled parameters as follows:

- High radiation risk sites are subject to control twice a year;
- Medium radiation risk sites are subject to control once a year;
- Low radiation risk sites are subject to control every two years.

Living environment object	*Controlled parameter*
Background radiation	rate of ambient gamma dose
Air	Rn-222
Soil	Natural radionuclines
vegetation	total alpha-activity
Mining and surface waters	total alpha-activity, total beta-activity, Ra-226, natural uranium
Sediments	Natural radionuclides

These laboratories did not form part of the present verification; information with regard to these laboratories can be found in the Commission's verification report concerning the *Kozloduy*-NPP.

6 NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

6.1 MINISTRY OF ENVIRONMENT AND WATER AND MINISTRY OF HEALTH

The Ministry of Environment and Water (MOEW) and the Ministry of Health (MH) have statutory duties to monitor environmental radioactivity throughout Bulgaria (National System for Environmental Monitoring - NSEM), including in the vicinity of the *Kozloduy* NPP. (The national environmental radioactivity monitoring programme was not subject of the present verification; information with regard to these laboratories can be found in the Commission's verification report concerning the *Kozloduy*-NPP.

6.2 THE MINISTRY OF ENVIRONMENT AND WATER (MOEW)

6.2.1 Introduction

The Ministry of Environment and Waters is the competent authority that implements the radiological monitoring of the environment in Bulgaria including the regions of former uranium production comprising also the region of the town of *Buhovo* and the village of *Eleshnitsa* under an overall radiation monitoring programme.

The MOEW's national programme consists of six regional programmes. The execution of these regional programmes is entrusted to the EEA's *Burgas*, *Vratsa, Varna, Stara Zagora, Montana,* and *Pleven* offices. These were not part of the present verification.

6.2.2 Environmental Executive Agency (EEA)

The Ministry of Environment and Water (MOEW), through the Environmental Executive Agency (EEA) and its regional bodies (Regional Inspection of Environment and Water - RIEW) carries out a specialized radiation monitoring in the country.

The National system for environmental radiological monitoring (not part of this verification) aims at early detection of the deviations from the radiation parameters' permissible levels in the main components of the environment – air, water and soil. 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 the 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.

The continuous and periodic monitoring of the radiation parameters of the environment's main components aimed at ensuring up-to-date information for the state and local management authorities and the public is based on a radiation monitoring programme. The programme is approved by the Minister of Environment and Waters and is a part of the National System for Environmental Monitoring (NSEM). It includes a network of surveillance posts, a defined periodicity of measurements and a set of radiation parameters that are monitored.

The field radiation measurements, sampling and laboratory and analytical activities are carried out by the radiation measurement laboratories within the Laboratory and Analytical Activities Directorate of the EEA in Sofia and in the regional laboratories in *Burgas, Varna, Vratsa, Montana, Pleven, Plovdiv* and *Stara Zagora*.

These laboratories ensure the necessary information on the environmental radiation status for the regions monitored by them. A set of radiation parameters is measured, for determination of the radioactivity levels of all components of the environment.

Data are collected, handled and stored in a database, which is part of the Central database of the EEA. Specialized software is used to visualize the information available.

The Ministry of Environment and Waters (MOEW) is the competent authority that implements monitoring of the radiation status of the environment in the regions of former uranium production including the region of the town of *Buhovo* and the village of *Eleshnitsa* under a programme that was a part of an overall radiation monitoring programme.

Sampling and measurement network (regions of *Buhovo* and *Eleshnitsa*)

The radiometric measurements, the sampling and the analytical work in the regions of *Buhovo* and *Eleshnitsa* are performed by the Laboratory for Radiation Measurements within EEA-MOEW (which was not part of this verification). The network for both regions and the monitored parameters are shown in Tables 1 and 2.

Table 1: Sampling programme near the town of *Buhovo* as performed by the *Dial Ltd.* laboratory

Sample type	No of points	Location of sampling point	Monitored parameters
Air	2	town of *Buhovo*	U-238, Ra-226, Ra-228, K-40, Cs-137, Pb-210, Be-7 [mBq/m^3]
		village of *Yana*	
Soil	3	town of *Buhovo*	U-238, Ra-226, Th-232, K-40, Pb-210, Cs-137 [Bq/kg]
		village of *Yana*	
		village of *Seslavtsi*	
Surface water	4	*Lesnovska* River at *Dolni Bogrov* village	Total alpha, total beta [Bq/l], U [mg/l], Ra-226, [mBq/l]
		Kremikovska River after influx of adit No 93 waters	
		Yaneshnitsa River near *Yana* village	
		Gully after *Chora* section purification plant	
Mining (drainage) water	3	Adit No 93, *Kremikovtsi*	Total alpha, total beta [Bq/l], U [mg/l], Ra-226, [mBq/l
		Adit No 123*, Seslavtsi*	
		Gully after *Buhovo* tailings pond	
Sediments	4	*Lesnovska* River at *Dolni Bogrov* village	U-238, Ra-226, Ra-228, K-40, Cs-137, Pb-210, Be-7 [mBq/m^3]
		Kremikovska River after influx of adit No 93 waters	
		Yaneshnitsa River near *Yana* village	
		Gully after *Chora* section purification plant	

Table 2: Sampling programme near the village of *Eleshnitsa* as performed by the *Drujba* mining and processing company

Sample type	No of points	Location of sampling point	Monitored parameters
Soil	3	*Eleshnitsa* village	U-238, Ra-226, Ra-228, K-40, Cs-137, Pb-210, Be-7 [mBq/m^3]
		Kopitoto quarry	
		Polyane shaft	
Surface water	4	*Zlataritsa* river before flowing to *Mesta* River	Total alpha, total beta [Bq/l], U [mg/l], Ra-226, [mBq/l]
		Gully below Eleshnitsa village	
		Mesta River after *Eleshnitsa* site	
		Spring in *Lozyata* locality	
		Gully after the tailings pond	
Sediments	4	*Zlataritsa* River before flowing to *Mesta* River	Total alpha, total beta [Bq/l], U [mg/l], Ra-226, [mBq/l]
		Gully below *Eleshnitsa* village	
		Mesta River after *Eleshnitsa* site	
		Spring in *Lozyata* locality	
		Gully after *Zvezda* tailings pond	

The radiological monitoring covers:

- continuous measurements of the gamma dose rate – through the Local automated radiological monitoring system (LARMS) in the *Buhov*o uranium mining region at two local monitoring stations (LMS), namely in the village of *Yana* and in the town of *Buhovo* (see above);
- discrete measurements of the gamma dose rate at all points of the network;
- periodical monitoring of the atmospheric radioactivity including automated sampling of atmospheric aerosols, once per month, at the LMSs in *Buhovo* and *Yana* followed by gamma-spectrometric analysis for the assessment of the volume specific activity of the natural and artificial radionuclides U-238, Ra-226, Ra-228/Th-232, Th-230, K-40, Pb-210 and Cs-137;
- periodical monitoring of uncultivated soils and waste products from dumps and tailings ponds; samples from the 0-20 cm surface soil bed are taken and analysed once a year in order to determine the specific activity of the natural and artificial radionuclides U-238, Ra-226, Th-232, Th-230, K-40, Pb-210 and Cs-137;
- periodical monitoring of surface water from rivers and other water basins and of underground water in the vicinity of uranium mining sites; samples are taken once per year. Total alpha and total beta activity, natural uranium and Ra-226 are measured;
- periodical monitoring of waste/mining water; samples are taken once per year. Total alpha and total beta activity, natural uranium and Ra-226 are measured applying radiochemical analysis;
- periodical monitoring of sediments; samples are taken once per year. In practice, sediment samples are taken at all surface water monitoring posts located in rivers, surface reservoirs and catchment gullies for further gamma spectrometry analysis. The specific activity of natural and artificial radionuclides is measured: U-238, Ra-226, Th-232, Th-230, K-40, Pb-210 and Cs-137.

The sampling, reception, preparation and analysis of the environmental samples are performed in accordance with methods complying with the Quality System requirements (BDS EN ISO 17025).

The results of the environmental radiological monitoring in the former uranium mining sites are published in the periodic publications of the EEA. Quarterly and Annual Bulletins are available on the web-site of the Agency.

Local automated radiological monitoring system in the Buhovo uranium production region

In 1999, under the Phare programme, within a project covering the area of the municipality of *Kremikovtsi* (the town of *Buhovo* and the village of *Yana*) a local automated radiological monitoring system (LARMS) for the *Buhovo* uranium production region was set up and made operational. In accordance with the complex programme for elimination of the consequences resulting from the uranium production in the region this system aims at monitoring key radiological parameters and their impact on the meteorological environment before, during and after completion of the abandonment and reclamation activities in the region of *Buhovo-Yana-Seslavtsi*.

The system comprises two Local Monitoring Stations (LMS) located in the village of *Yana* (container No 1) and in the town of *Buhovo* (container No 2).

Both monitoring containers have stationary sampling devices installed for aerosol samples (universal sampling device for aerosol samples, type *Thermo Scientific FH 95*, electronically stabilized flow rate of 1 m^3/h, membrane filters Ø 47 mm), used for a follow-up lab analysis of natural and artificial radionuclides' content in the air. The samples are analyzed to determine the volume specific activity of the key dose-forming radionuclides in the air.

Depending on the conditions (dust, humidity, temperature, etc.) the sampling continues for 25-30 days; the volume sampled is over 600 m^3 of air.

A continuous surveillance of the following parameters is also carried out:

- Gamma dose rate in the air (radiation background), μSv/h (intelligent gamma probe type *Thermo Scientific FHZ 621 B*, energy range 40 keV to 1.3 MeV, dose rate range 30 nSv/h to 1 Sv/h);
- Concentration of radioactive emanation of Rn-222 in surface air, Bq/m^3 (microprocessor controlled Portable Radon Gas Surveyor *Silena* type *5S*, range 4 to 2 000 000 Bq/m^3);
- Concentration of total dust in surface air, μg/m^3 (total dust monitor type *Thermo Scientific FH 62-1*, electronically stabilized flow rate of 1 m^3/h);
- Meteorological parameters: wind direction and speed, temperature and relative humidity, atmospheric pressure and precipitation volumes (type *Babuc ABC*).

The aerosol filters are submitted to the laboratory for gamma spectrometric analysis using a *Canberra* low background gamma spectrometry system with a semiconductor detector of the type HPGe *NRGC 4019*. The analyses are carried out in compliance with the BDS IEC 61452 standard. Applying appropriate calibration the filters are analyzed and the volume specific activity for U-238, Ra-226, Ra-228 (via Ac-228), K-40, Pb-210, Cs-137 and Be-7 is calculated. The measurement time is between 60 and 96 hours.

The verification team visited container number 2, placed on the fenced-in meadow at the entrance of the *DIAL Ltd.* laboratory in the town of *Buhovo*. The container is equipped as described above. All systems were functioning at the time of the verification;

The verification does not give rise to any specific remarks.

The Central station (CS) of this monitoring system (which was part of the *Kozloduy* verification) is located at EEA-MOEW in *Sofia*. The Agency is responsible for the technical maintenance and operation of the Local Automated Radiological Monitoring System in the region of *Buhovo*.

The information from the LARM-System is available to the public. The results from the annual radioecological monitoring programme of EEA-MOEW are published in quarterly and annual bulletins on the radiological status of the environment.

6.3 MINISTRY OF HEALTH – NATIONAL CENTER FOR RADIOLOGY AND RADIATION PROTECTION

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 RIPCPHs have radiation control units, located in *Burgas, Varna, Vratsa, Plovdiv* and *Rousse* charged with monitoring in relation to public health.

Through NCRRP the Ministry of Health implements the specialized State Health Control on the radiation parameters of the living environment in areas surrounding the former uranium production and processing sites.

The State Health Control is performed as follows:

- consultation on and approval of the Radiation Protection section of the projects for technical and biological re-cultivation of uranium production and processing sites;
- participation in committees for approval of reclaimed and re-cultivated lands.

In addition, in the vicinity of the former uranium ore mining and processing sites, tests of the living environment factors are performed. The living environment factors control includes:

- Measurement of the radiation parameters of the living environment:
  - measurement of gamma dose rate;
  - measurement of Rn-222 volume specific concentration in the air;
  - sampling and analysis of natural radionuclides' content in water, soil, sediment, vegetation and food samples;
- Compatibility assessment of the controlled parameters with the effective rules and regulation, and determination of the additional above-background exposure of the population;
- Compilation of instructions aimed at the elimination of discrepancies;
- Drawing up statements and issue of penalty notices in case of administrative breaches.

A focused control is applied in case of complaints from citizens, state and municipal authorities and organizations.

7 CONCLUSIONS

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

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the remediated former uranium mining and processing sites at *Buhovo*, *Chora*, *Byalata Voda*, *Iskra* and *Eleshnitsa* as well as the verified parts of the national monitoring system for environmental radioactivity are adequate. The Commission could verify the operation and efficiency of these facilities.

(2) A few topical suggestions and recommendations are formulated. These aim at improving some aspects of the remediation and the environmental surveillance of former uranium sites and do not discredit the fact that environmental monitoring around former uranium sites is in conformity with the provisions laid down under Article 35 of the Euratom Treaty if the measures are maintained in the long term and the recommendations implemented.

(3) The verification team recommends studying the issue of leachates accumulating inside the mines below the outflow surface, in particular with regard to any contamination of ground water in the very long run, and to consider measures to overcome the highlighted issues.

Concerning the 'new' tailings pond at *Buhovo* the team recommends for the near future a full remediation.

After remediation of any tailings pond, restrictions to agricultural use of the concerned land should apply: e.g. no deep rooting trees (may destroy upper remediation layer), no deep ploughing, grazing restrictions.

Furthermore, the team recommends for all remediated sites installing radiological monitoring (e.g. with regard to radon emanation at the site and potential groundwater contamination). Such monitoring would have to be in place for long term surveillance; adequate administrative and financial support would be necessary.

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

(5) The Commission services ask the Bulgarian competent authority to inform them of any progress or significant changes with regard to the situation at the time of the verification. In particular, they will closely follow up the progress made with respect to point (3).

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

(7) Finally, 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

THE VERIFICATION PROGRAMME –OVERVIEW

Art. 35 EURATOM verification mission
Bulgaria – uranium sites

(10-14 August 2009)

Day	Event
09.08.2009 Sunday	Arrival of EC teams in Sofia.
10.08.2009 Monday	Opening meeting, introductions, presentation of the participants and the programme of the visit. Allocation of inspection teams Venue: Ministry of Economy and Energy (MEE)
	Presentation on general uranium site related matters (Ecoengineering-RM EOOD)
	Both teams: Travel to Buhovo; introduction to and verification of the activity of the Chora site - Installation for sorption purification for uranium-contaminated mine waters (ISPUCMW)
	Both teams: verification of the dosimetrical laboratory at Buhovo.
	Both teams: Verification at the Buhovo tailings site; return to Sofia
11.08.2009 Tuesday	Both teams: Travel to Eleshnitsa village (hotel stay at Bansko).
	Both teams: verification at the Installation for regeneration purification of ion-exchange resins (LRPIR) at Eleshnitsa
	Both teams: Verification at the premises for yellow-cake storage at Eleshnitsa
12.08.2009 Wednesday	Both teams: Verification at Eleshnitsa tailing and the adjoining facilities
	Return to Sofia.
13.08.2009 Thursday	Both teams: Preparatory meeting at the office of Ecoengineering-RM EOOD
	Team-1: Travel to and verification at the Byalata voda site (village of Ochusha), installation for sorption purification of uranium-contaminated mine waters (ISPUCMW); verification of installations for sorption purification of uranium-contaminated mine waters (ISPUCMW) (Byalata voda) Team-2: Travel to and verification at the Iskra site (town of Novi Iskar), installation for sorption purification of uranium-contaminated mine waters (ISPUCMW); verification of installations for sorption purification of uranium-contaminated mine waters (ISPUCMW) (Iskra)
	Both teams: Return to Sofia
14.08.2009 Friday	Final meeting at the Ministry of Economy and Energy • Presentation of preliminary inspection conclusions • Discussion
	Return of EC teams to Luxembourg

Team-1: Constant Gitzinger, Adriana Godeanu Metz
Team-2: Eberhardt Henrich
Head of verification team: Constant Gitzinger

APPENDIX 2

DOCUMENTATION RECEIVED AND CONSULTED WEB SITES

In reply to a specific questionnaire on Art.35 matters that was submitted by the Commission services to the competent Bulgarian authorities in preparation of the visit, an explanatory text document with numerous detailed appendixes was received. This document entitled "Preliminary information on the implementation of the obligations under Article 35 of the EURATOM treaty" was prepared by the Bulgarian authorities for the purposes of the verification mission of the EC. The document answers relevant questions concerning uranium mining and milling in Bulgaria (legal situation; competent authorities; uranium mining and milling - historical and actual situation; radiological site monitoring and remediation activities, etc..

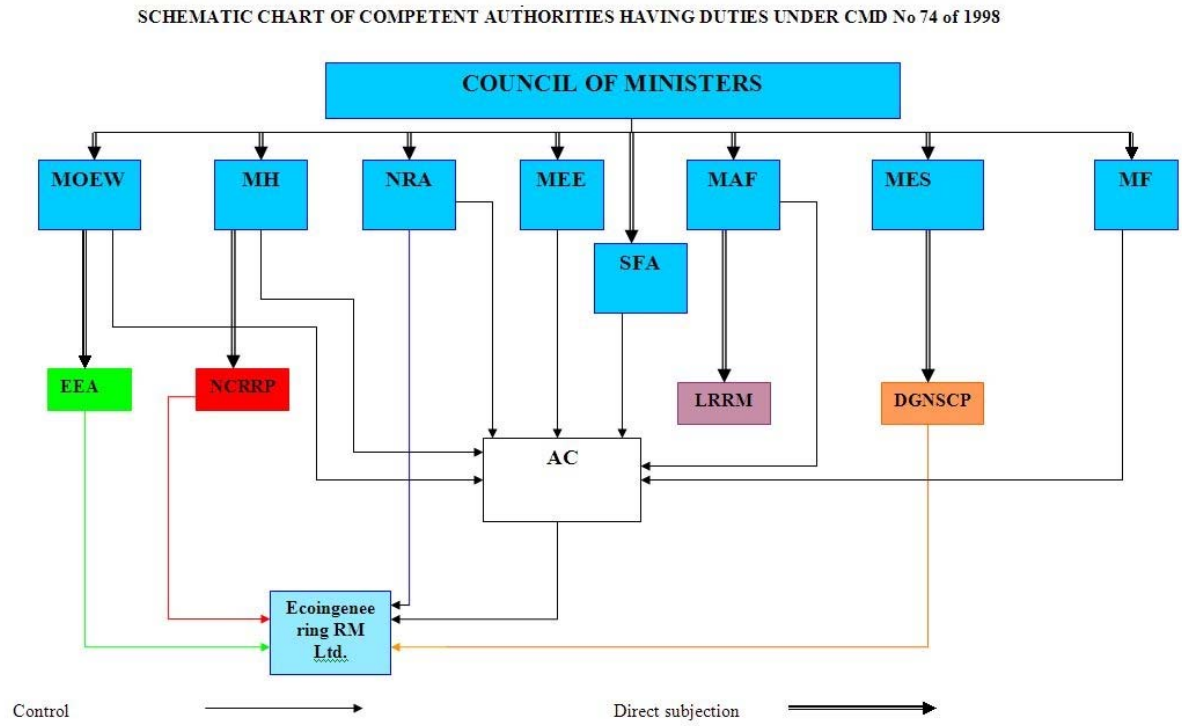
Note: This list does not include various other documents that were asked for (and received) during the verification activities such as calibration certificates, standard operation procedures, quality assurance procedures, source records and measurement results, technical drawings, legislative texts,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

Consulted web sites

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

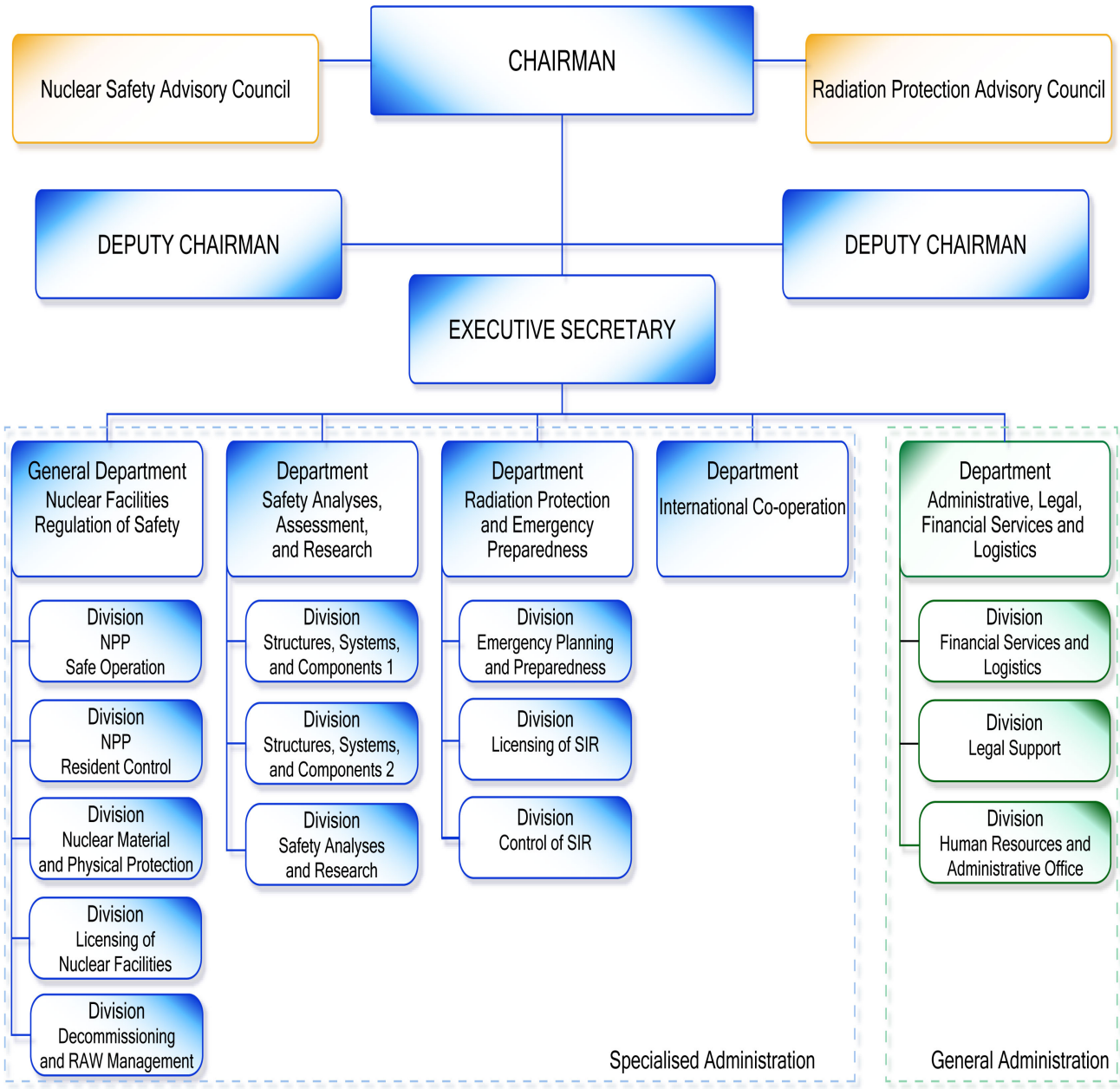
APPENDIX 3

MINISTRIES AND BODIES HAVING COMPETENCE IN RADIATION PROTECTION AND ENVIRONMENTAL RADIATION MONITORING



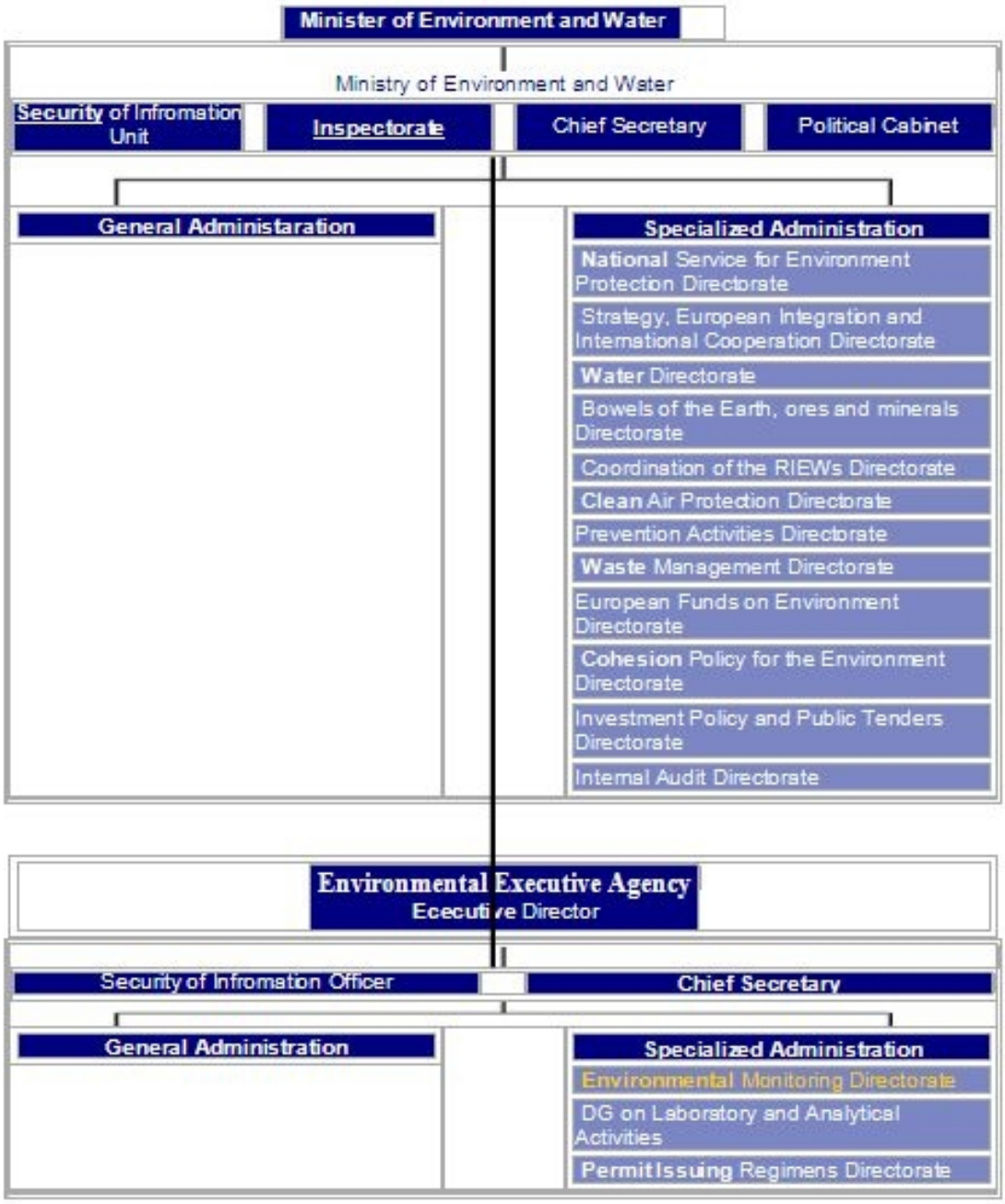
APPENDIX 4

NUCLEAR REGULATORY AGENCY - ORGANIZATIONAL CHART



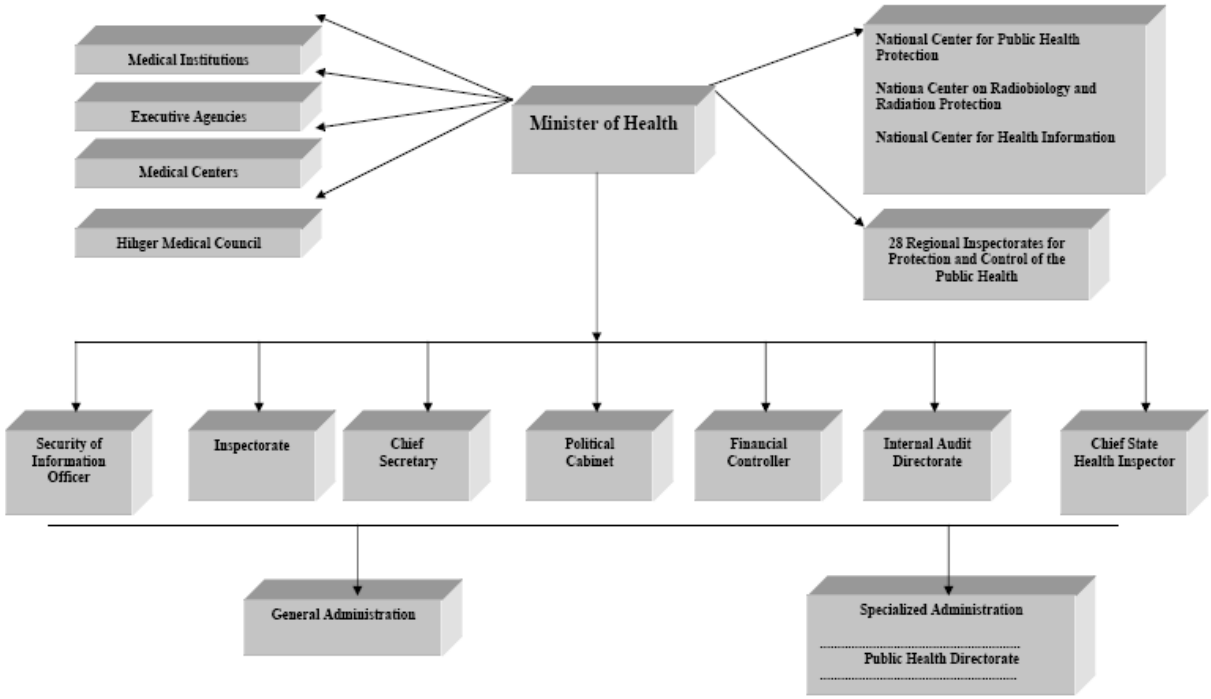
APPENDIX 5

MINISTRY OF ENVIRONMENT AND WATERS - ORGANIZATIONAL CHART



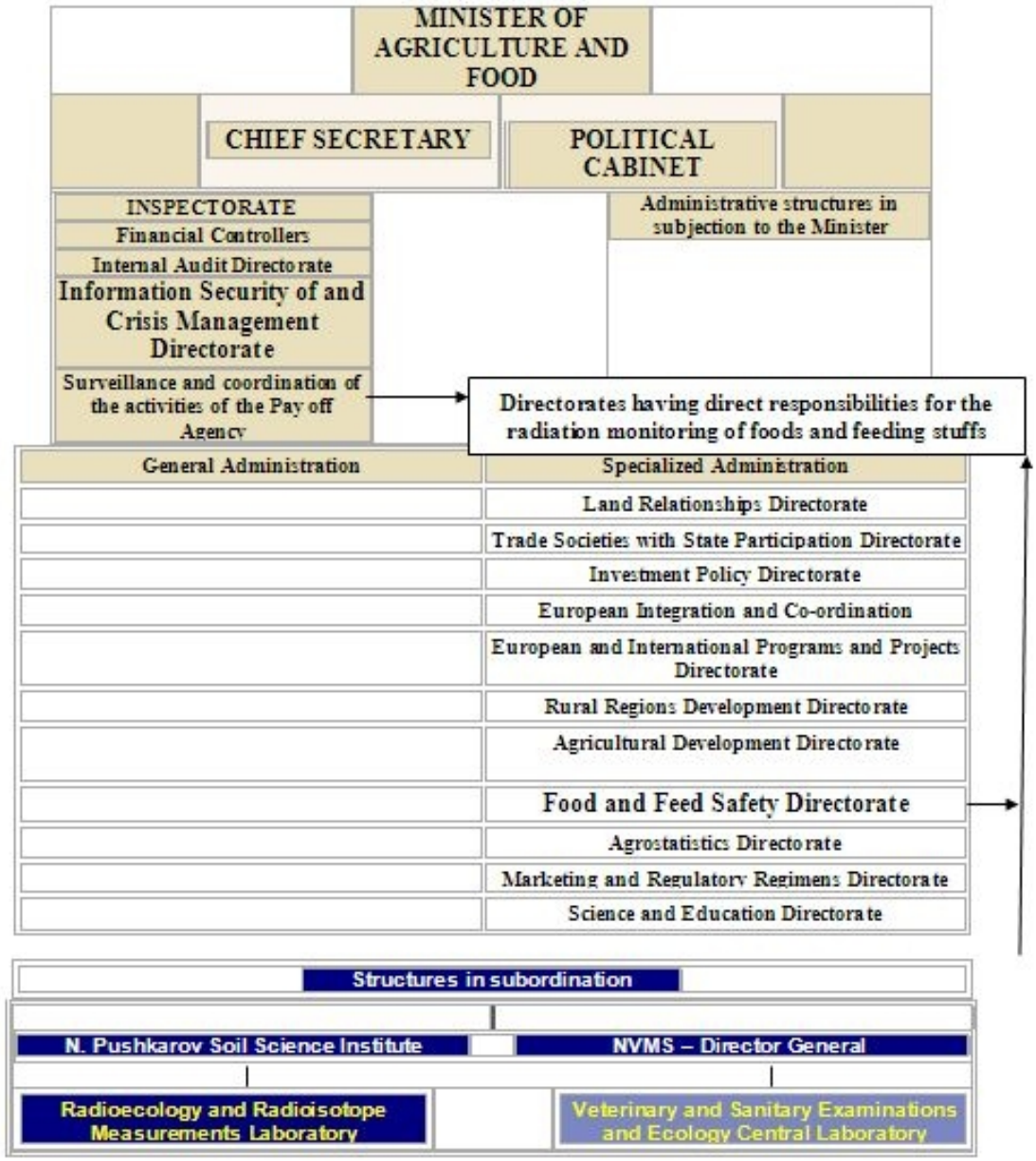
APPENDIX 6

MINISTRY OF HEALTH - ORGANIZATIONAL CHART



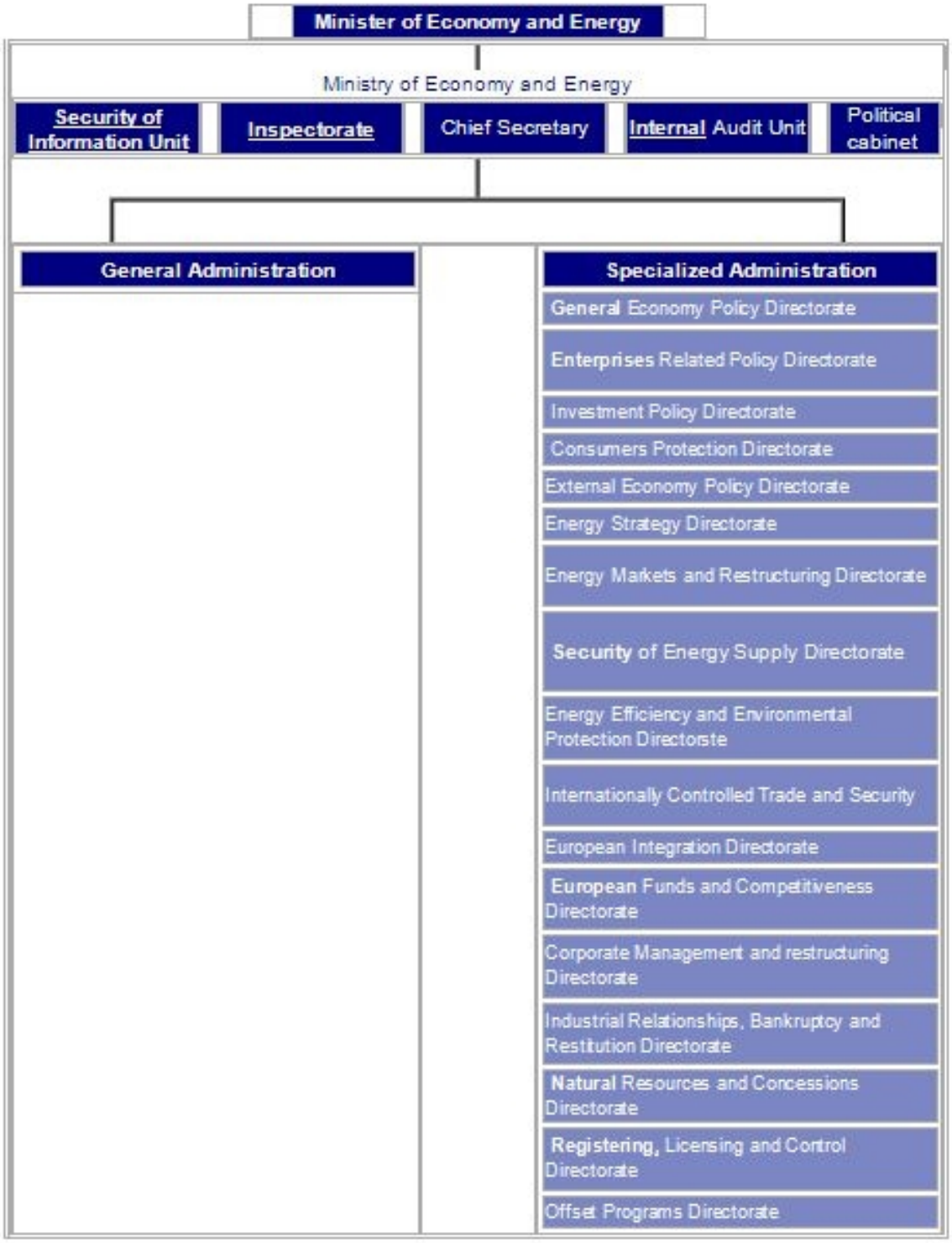
APPENDIX 7

MINISTRY OF AGRICULTURE AND FOOD – ORGANIZATIONAL CHART



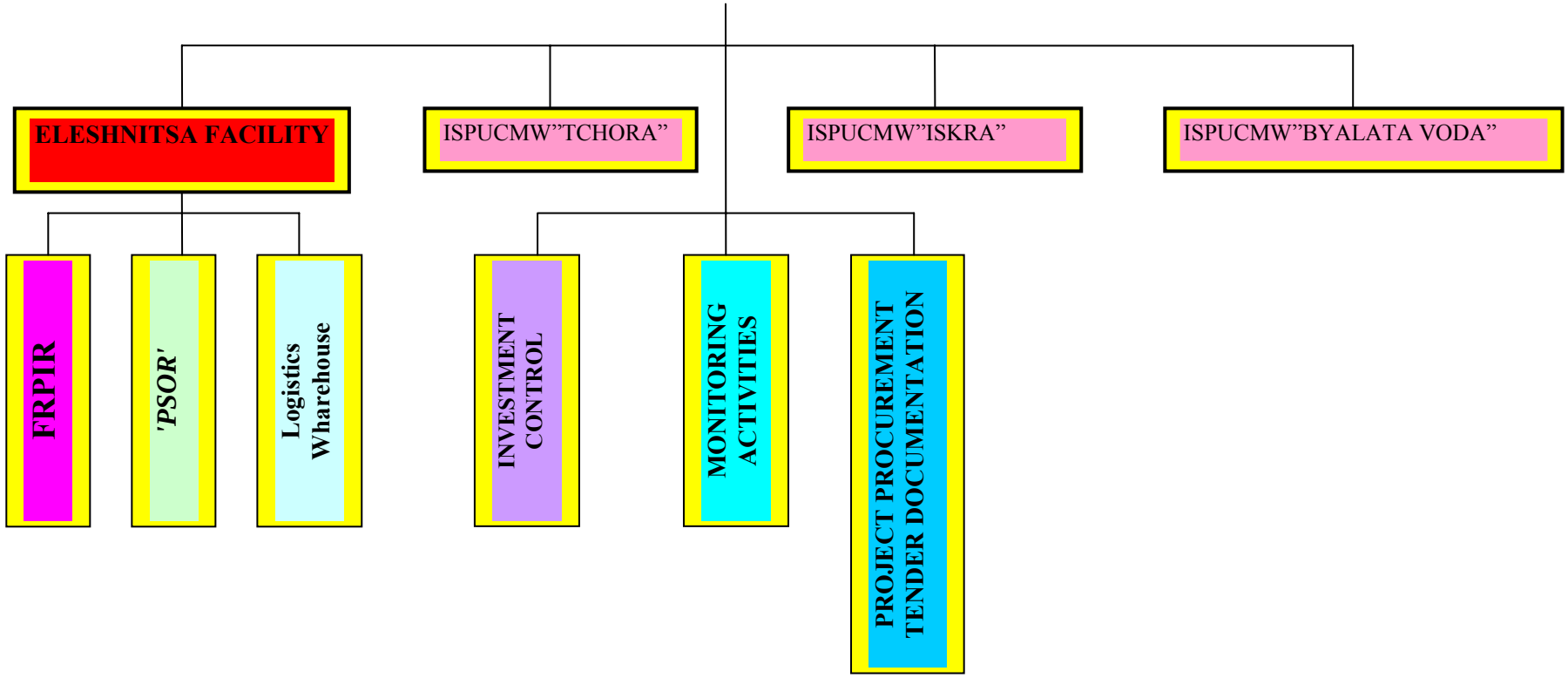
APPENDIX 8

MINISTRY OF ECONOMY AND ENERGY – ORGANIZATIONAL CHART



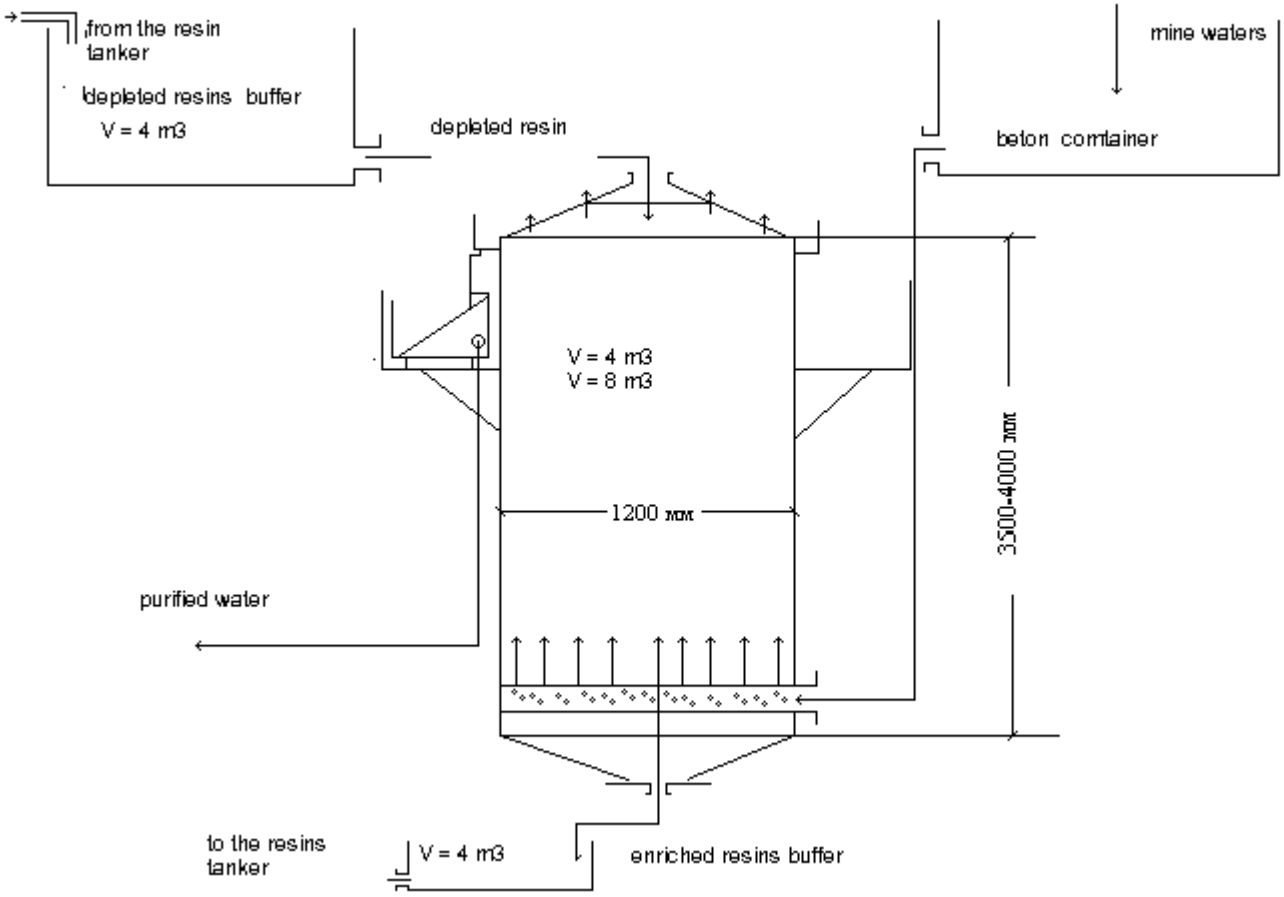
APPENDIX 9

ECOENGINEERING – ORGANIZATIONAL CHART



APPENDIX 10

SCHEMATIC DESIGN OF AN INSTALLATION FOR PURIFICATION OF URANIUM CONTAMINATED WATERS USING ION EXCHANGE RESINS



APPENDIX 11

MONITORING PROGRAMME 2009 FOR THE SITES INDICATED IN CMD 74 OF 1998

(NCRRP CLASSIFICATION ACCORDING TO THE LEVEL OF RADIATION RISK)

№	(Closed) uranium mining site	Number of mines	Number of monitoring points	Underground water	Surface water
1	**2**	**3**	**4**	**5**	**6**
Sites with High radiation risk according to the classification by the NCRRP					
1	**Druzhba 1 and 2**	2	17	9	8
2	***Metalurg* plant and tailings pond**	1	7	4	3
3	**Sliven**	1	4	4	-
4	**Fifth shaft**	1	6	5	1
5	**Naretchen**	1	2	1	1
	Sub-Total:	**6**	**36**	**23**	**13**
Sites with Medium radiation risk according to the classification by the NCRRP					
6	**Shafts 7 and 8**	2	14	9	5
7	**Izgrev**	1	13	8	5
8	**Smolyanovtsy shaft**	1	4	3	1
9	**Selishte**	3	6	5	1
10	**Byalata voda**	1	2	1	1
11	**Senokos**	1	9	7	2
12	**Proboynitsa**	2	4	3	1
13	**Beli Iskar***	2	4	2	2
14	**Babeshka river**	1	4	3	1
15	**Melnik**	1	5	3	2
16	**Pripetchene**	1	3	3	-
17	**Sugarevo**	1	3	1	2
18	**Dobralak**	1	3	1	2
19	**Partizanska (Kirilova) poliana**	2	7	2	5
20	**Yavorovets**	1	6	3	3
21	**Ribaritsa**	1	4	1	3
	Sub-Total:		**91**	**55**	**36**
ISPUCMWs - according to permits, issued by the Basin Directorates to the MOEW for water embedding					
22	**ISPUCMW "Chora"**	1	6	5	1
23	**ISPUCMW "Iskra"**	1	5	3	2
	Sub-Total:	**2**	**11**	**8**	**3**
Sites with Low radiation risk according to the classification by the NCRRP					
24	**Bortche**	1	5	2	3

№	(Closed) uranium mining site	Number of mines	Number of monitoring points	Underground water	Surface water
25	**Tcheshmata**	1	3	3	-
26	**Navasen**	1	4	3	1
27	**Troyan**	1	3	2	1
28	**Orlov dol**	1	3	2	1
29	**Madrets**	1	3	2	1
30	**Vladimirovo**	1	2	2	-
31	**Zdravets**	1	2	2	-
32	**Brezhani**	1	1	1	-
33	**Igralishte**	1	2	1	1
34	**Gabra**	1	3	1	2
35	**Golak - sreden**	1	4	2	2
36	**Pratevoto**	1	6	3	3
37	**Planinets**	1	3	2	1
38	**Beslet**	1	4	2	2
39	**Krupnik**	1	3	3	-
40	**Svidnya**	1	4	2	2
41	**Belmeken**	1	6	2	4
42	**Dobarsko**	1	2	2	-
43	**Katina**	1	2	-	2
44	**Zlatolist**	1	2	1	1
45	**Kosovo**	1	1	1	-
46	**Skrebatni polyani**	1	3	1	2
47	**Gradevo**	1	1	-	1
48	**Bazelivo dere**	1	3	1	2
49	**Lipets**	1	3	1	2
50	**Bablon**	1	3	-	3
51	**Vitina**	1	3	1	2
52	**Shtodenski vrah**	1	3	2	1
53	**Bukovo**	1	2	-	2
Sub-Total:			**89**	**47**	**42**
Total for 2009			**227**	**133**	**94**

APPENDIX 12

METHODOLOGY FOR SAMPLING OF WATER, SOIL AND SEDIMENTS AND FOR FIELD MEASUREMENTS

Water - surface and underground

The sampling of surface and underground water is carried out at each of the established water monitoring points, which are specifically marked with permanent markings.
During the water sampling the electrical conductivity, pH, Eh, ttemperature and dissolved O_2 are measured using portable, temperature compensated equipment (*WTW 340i* from Germany), with a set of sensors, which are easily calibrated under field conditions.
At water monitoring points obligatory measurements are carried out of the level, discharge, and water temperature. Discharge measurement is carried out using a volumetric method – through a measuring container with a defined volume and a stopwatch – for catchment drain water, underground mine drifts and naturally outpouring boreholes. The mean value of three consecutive measurements is accepted as credible. For sources without catchment, small streams and rivers, the method uses portable overflow drains (type *Cipolletti*, *Thomson*) or hydraulic propellers.

Sampling of surface water

The sampling of water from surface streams and rivers is carried out using an appropriate recipient (PVC-can with a volume of up to 5,0 litres) plunged below the water level at the location with the fastest flow, , paying attention that the sample is not contaminated with outside impurities (for instance sludge from the river bed).

Sampling of underground water

The sampling of underground water is carried out with a submersible pump (*Grundfos* model *MP-1* or *SQ 3-40*, for depths from 50 to 90 m), or with a centrifuge motor pump. The water sample is taken after constant values of the electrical conductivity, pH and temperature are reached or, alternatively, if the water quantity is at least three times greater than the borehole volume. The sampling from naturally outpouring boreholes is direct

Soils, sediments, and technologically contaminated terrains

All soil sampling points are defined for each of the local monitoring networks and are permanently marked.
In the cases where no monitoring networks are established, individual sampling points or profiles at the spoil heaps are defined.
Soil samples are taken under dry weather conditions. The samples are taken from depths of 25-30 cm for arable land and 10-15 cm for uncultivated or forest areas, at four points, N, S, E and W, approximately 5 m from the permanent marking. Using a soil sampler, about 1.5 dm^3 of soil is taken. The four samples are mixed, then divided in four parts; about 1.5-2.0 kg is filled in a paper bag. The sample number, point number and the sampling date are marked on the paper bag. A paper label with the same data is put into the bag. The sampling place is photographed, GPS–coordinates are taken.
Sampling from technologically contaminated terrains is carried out in the same way. During sampling, measurements of the gamma dose rate are carried out, either in contact with the soil or at 1 m above ground. Measurements are carried out using a calibrated scintillation radiometer, type *SRP 68-01* or with a gamma-ray detector with external probe, type *FH-40GL-10*.
Sediment sampling is carried out at the same points, where surface water monitoring is done, normally at the end of summer, after a long period of drought. Sediment sampling is carried out directly from the river beds. The material, with a volume of 8 to 10 dm^3, is divided in four parts which are piled up on the river bank for 2-3 hours at an appropriate place for drainage. After that an homogenised sample comprising about 1.5 – 2 kg from each part is taken. The sample is packed in a labelled plastic bag,

with the sample number, as well as the sampling point number and the sampling date being indicated. The sampling place is photographed, GPS–coordinates are taken.
Surface α and β contamination measurements are performed at the posts, facilities, sorption installations, working premises and spoil heaps. They are carried out with field α, β, γ detectors with an external probe of the type *FH-40GL-10*.

Radon at the mine outlets

Radon measurements, at shafts and stulms of the closed sites, are carried out twice a year with a radiation meter *AlphaGUARD PQ 2000*. Measuring time is 30 minutes (three consecutive measurements of 10 minutes each).
Simultaneously with the radon concentration measurements, the device continuously supplies data on temperature, atmospheric pressure and air humidity.

In parallel with the observations, sampling and field measurements, a technical inspection of the status of the facilities is carried out, including boreholes, pits and their outlets, stulms and their outlets, status and terrain markings. All observed changes of terrain status are documented, an assessment is carried out and a proposal for any necessary repair, recovery or replacement measures is issued.