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DIRECTORATE D - Nuclear Energy
Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

URANIUM SITES

Environmental Radioactivity and Discharge Monitoring and part of National Monitoring System for Environmental Radioactivity

Czech Republic

18 to 22 October 2010

Reference: CZ-10/07

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. (Part of the) National Monitoring System for Environmental Radioactivity.
DATE:	18 to 22 October 2010
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DATE OF REPORT:	2011-07-05

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TECHNICAL REPORT

1 ABREVIATIONS

ALARA	As Low As Reasonably Achievable
CMA	Czech Mining Authority *(Český báňský úřad; ČBÚ)*
CEI	Czech Environmental Inspectorate, controlled by the Ministry of the Environment *(Ćeská inspekce životního prostředí)*
CHI	Czech Hydrometeorological Institute *(Český Hydrometeorologický Ústav; ČHMÚ)*
ČIA	*Český institut pro akreditaci, obecně prospěšná společnost* (Czech Institute for Accreditation)
ČMI	*Český Metrologický Institut* (Czech Metrological Institute)
ČSFR	(former) CzechoSlovak Federal Republic
ČSSR	(former) CzechoSlovak Socialist Republic
ČSUP	(former) Czechoslovak Uranium Industry enterprise
DG ENER	Directorate General for Energy (of EC)
DG JRC – IES	Directorate General Joint Research Centre – Institute for Environment and Sustainability (of EC)
DG TREN	(former) Directorate General for Energy and Transport (of EC)
DIAMO	Mining state enterprise, with headquarters in *Stráž pod Ralskem*. From 1967 onward named Czechoslovak Uranium Industry (in Czech abbreviated as *ČSUP*) on 31 March 1992, the Concern enterprise *ČSUP* - *Příbram*, was renamed to DIAMO
EC	European Commission
EEA	Environmental Executive Agency
EEC_{Rn}	Equilibrium Equivalent Radon Concentration
EIA	Environmental Impact Assessment
EURDEP	EUropean Radiological Data Exchange Platform
GEAM	branch of DIAMO at Dolní Rožínka
GM	Geiger Müller (radiation detector device)
GPS	Global Positioning System
HPGe	High Purity Germanium (gamma radiation detector device)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IRMM	Institute for Reference Materials and Measurements (of EC DG JRC)
IRIS	Integrated Radiation Information System
ISL	In Situ Leaching
ISO	International Organization for Standardization
LLD	Lower Limit of Detection
LSC	Liquid Scintillation Counter (radiation detector device)
MIT	Ministry of Industry and Trade *(Ministerstvo průmyslu a obchodu; MPO)*
ME	Ministry of the Environment *(Ministerstvo životního prostředí; MŽP)*
MF	Ministry of Finance *(Ministerstvo financí)*
MH	Ministry of Health *(Ministerstvo zdravotnictví)*
ML	'Mother Liquor' (ISL remediation)
NaI(Tl)	Sodium Iodide Thallium activated (gamma radiation detector device)
NPP	Nuclear Power Plant

OJ	Official Journal
OW	Observation Well
PC	Personal Computer
PHS	Public Health Stations (State administration and state health supervision and occupational safety, managed by the Ministry of Health; *hygienické stanice)*
PTB	*Physikalisch-Technische Prüfanstalt, Braunschweig* (Germany)
RC	Regional Centre (of the State Office for Nuclear Safety, SÚJB)
RIP	Resin-in-Pulp (uranium production technology)
RMN	Radiation Monitoring Network
SÚJB	*Statní úřad pro jadernou bezpečnost* (State Office for Nuclear Safety; SONS)
SÚPUP	*Stavební úřad pro uranový průmysl MPO* (Construction Authority for the Uranium Industry; Ministry of Industry and Trade)
SÚJCHBO	*Státní ústav jaderné, chemické a biologické ochrany* (National Nuclear, Chemical and Biological Protection Institute; NBC)
SÚRO	*Státní ústav radiační ochrany* (National Radiation Protection Institute)
SVÚ	*Sdružení výkonných umělců* (State Veterinary Institute)
SZLAB	*Středisko zkušebních laboratoří* (Laboratory contracted by the operator at Dolní Rožínka)
SZPI	*Státní zemědělská a potravinářská inspekce* (Czech Agricultural and Food Inspection Authority)
TLD	Thermo Luminescence Dosimeter
TÚU	Branch of DIAMO at Stráž pod Ralskem
ÚKZÚZ	*Ústřední kontrolní a zkušební ústav zemědělský* (Central Institute for Supervising and Testing in Agriculture)
UPS	Uninterruptible Power Supply
ÚSVTRS	(former) Central Administration of Research and Mining of Radioactive Raw Materials
UTC	Universal Time Coordinated
VÚLHM	*Výzkumný ústav lesního a vodního hospodářství a myslivosti (*The Forestry and Game Management Research Institute)
VÚVTGM	Výzkumný ústav vodohospodářský T. G. Masaryka (T. G. Masaryk Water Management Research Institute)
WHO	World Health Organization
ZHP	*Zóna havarijního plánování* (emergency planning zone)

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 18 to 22 October 2010, two verification teams from DG ENER (former DG TREN) visited different uranium mining and milling sites around Stráž pod Ralskem (northern Czech Republic), and Brno (south-eastern Czech Republic). Representatives of the state owned enterprise DIAMO (státní podnik Stráž pod Ralskem) explained the different mining techniques and organised the extensive visits of both sites. 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 the Czech Republic. 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 teams were accompanied by representatives of the Czech authority, the State Office for Nuclear Safety (SÚJB). The teams also visited the regional branches of the State Office for Nuclear Safety (*Statní úřad pro jadernou bezpečnost*, SÚJB) in Ustí nad Labem and Brno, as well as the laboratories of the National Radiation Protection Institute (*Státní ústav radiační ochrany*, SÚRO) in Praha (Prague) and of the National Nuclear, Chemical and Biological Protection Institute (*Státní ústav jaderné, chemické a biologické ochrany*, SÚJCHBO) in Přibram-Kamenna (central Czech Republic).

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 Czech authority, the State Office for Nuclear Safety (SÚJB).

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

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

3 PREPARATION AND EXECUTION OF THE VERIFICATION

3.1 PREAMBLE

The Commission's request to execute an Article 35 verification was notified to the Permanent Representation to the European Union of the Czech Republic by letter (ENER D.4/CG/cn D(2010)65505, dated 02 June 2010.

Subsequently, practical arrangements for the implementation of the verification were made with SÚJB, the competent authority, which provided preliminary information on the Czech Republic legislation and its implementation with respect to radiation protection for uranium mining and milling sites.

The competent Czech authority SÚJB efficiently acted as co-ordinator and thus ensured not only that the verification programme could be fully implemented, but also that all 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 Czech competent authorities which 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).

Parts of the national environmental radioactivity monitoring network were also comprised in the verification as well as the laboratories concerned.

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 Czech 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:

***SÚJB Statní úřad pro jadernou bezpečnost* (State Office for Nuclear Safety):**

Mrs Ing Karla Petrová	Deputy Chairman for Radiation Protection
Mr. Miroslav Hemer	SÚJB regional centre Kamenná, head
Mr. Miroslav Jurda	SÚJB regional centre Kamenná
Mr. Miloslav Němec	SÚJB regional centre Kamenná
Mr Ing. Jan Horyna	Inspector, Section. of Fuel Cycle Radiation Protection
Mrs Ing. Jana Šeflová	Inspector
Mr Jan Matzner	Section of Fuel Cycle Radiation Protection, Director

Mr Zdeněk Neumann	SÚJB regional centre Ustí nad Labem
Mrs Marcela Trbolová Berčiková	SÚJB regional centre Ustí nad Labem

***SÚJCHBO (Státní ústav jaderné, chemické a biologické ochrany, v. v. i.)* National Nuclear, Chemical and Biological Protection Institute:**

Mr Stanislav Bradka	Director
Mr Tibor Mikeš	Consultant
Mr Ivo Burian	Head of Nuclear Safety Dept.
Mrs Zdena Veselá	Gamma spectrometry
Mrs Haná Sýbková	TLD
Mrs Jarosláva Buštová	Alpha/beta measurements

***SÚRO (Státní ústav radiační ochrany)* National Radiation Protection Institute**

Mr Jiři Hůkla	Deputy Director for Research and Development
Mrs Irena Češpírová	Head of Mobile Group

DIAMO,* state enterprise, *(státní podnik,) TÚU* division *Stráž pod Ralskem

Ing. Tomáš Rychtařik	director
Ing. Ludvík Kašpar	Vice-director for production and technology
Ing. Jiři Mužák, Ph. D.	Head of dept. of mathematical modelling
RNDr. Lubomír Neubauer	Head of dept. of ecology
Ing. Rostislav Dudáš	Head of dept of safety and health
Jiři Dohnal	Head of leaching fields and chemical station
Ing. Zdeněk Šrýtr	Head of desalination plant
Ilja Řihák	Head of mother liquor liquidation plant
Miroslav Stand	Site foreman – tailings pond
Ing. Pavel Varga	Dept. of ecology
Ing. Jana Kopalová	Head of laboratory centre
Ing. Lenka Bartáková	Laboratory analyst

DIAMO,* state enterprise *(státní podnik, odštěpný závod) GEAM* division *Dolní Rožínka

Mr Ing. Pavel Koscielniak	Division Manager
Mr Ing Jiři Jež	Deputy Manager for Ecology and Remediation Works

Povodí Labe, *státni podnik* (Hradec Králová)

Mr Jiři Vosáhlo	Technician (sampler)

4 LEGISLATION AND COMPETENT AUTHORITIES

4.1 LEGAL BASIS

4.1.1 List of legislative acts regulating the environmental monitoring

Act No 18/1997 Coll. of 24 January 1997 on the peaceful utilization of nuclear energy and ionizing radiation (Atomic Act) and amending certain acts.

This Act regulates:

a) the method of utilising nuclear energy and ionising radiation, and conditions for the performance of practices related to nuclear energy utilisation and radiation activities,
b) the system for the protection of people and the environment from undesirable effects of ionising radiation,
c) obligations during preparation for and implementation of intervention intended to reduce exposures to natural sources and exposures due to radiation accidents,
d) specific requirements for civil liability in the case of nuclear damage,
e) conditions for safe management of radioactive waste,
f) performance of State administration and supervision within nuclear energy utilisation, within radiation activities and over nuclear items.

The provisions of the act are implemented by the following decrees:

- **Decree No 307/2002 Coll.** on radiation protection, as amended by Decree No 499/2005 Coll.

This decree is in accordance with the Council Directive 96/29/Euratom of 13 May 1996 (basic safety standards) and regulates in particular:

a) details of the method and the scope of radiation protection during work at the workplaces where radiation activities shall be performed including the details related to delineation, identification, notification and approval of supervised and controlled areas at the workplaces,
b) details with regard to work activities associated with an increased presence of natural radionuclides or increased influence of cosmic radiation which lead or may lead to a significant increase in exposure of individuals (hereinafter referred to as “work activities with the increased exposure to natural sources”) in such a way that the affected workplaces and individuals, measurement scope and guidance levels for interventions to reduce the increased exposures to natural sources shall be set out,
c) details the rules for preparation or implementation of remedial actions to avert or reduce exposures as well as the guidance levels for the interventions to be laid down,
d) exemption levels, clearance levels, exposure limits, dose constraints, maximum permitted levels of natural radionuclide concentrations in building materials and maximum permitted levels of radioactive contamination of foodstuffs,
e) details the classification of ionising radiation sources, the categorisation of exposed workers and the categorisation of workplaces where radiation activities shall be performed,
f) technical and organisational requirements, procedures and guidance levels to demonstrate the radiation protection optimisation,
g) the scope and the method of ionising radiation source management, handling of radioactive waste and radionuclide discharge into the environment for which a licence shall be required, and it regulates the details for ensuring radiation protection during the radiation activities,
h) defines the quantities, parameters and the facts relevant for radiation protection and sets out the scope of monitoring, measurements, evaluation, verification, recording, registration and the method of data transfer to the State Office for Nuclear Safety.

This decree shall not apply to natural background exposures, i.e. to the radionuclides which are naturally contained in the human body, to cosmic radiation prevailing normally at ground level, and radiation caused by the radionuclides present in the earth's crust undisturbed by human activity, and other natural ionising radiation sources not modified by human activity.

- **SÚJB Decree No 214/1997 Coll.** on quality assurance in carrying out activities connected with the utilization of nuclear energy and activities leading to exposure and on the definition of the criteria for the classification and categorization of selected installations according to safety classes;

- **SÚJB Decree No 309/2005 Coll.** on provision of technical safety for classified equipment;

- **SÚJB Decree No 185/2003 Coll.** on the decommissioning of nuclear installations or Category III. or IV workplaces;

- **SÚJB Decree No 146/1997 Coll.** (as amended by SÚJB Decree No 315/2002 Coll.) specifying activities directly affecting nuclear safety and activities particularly relevant in terms of radiation protection, requirements on qualification and professional training, on method to be used for verification of special qualification and for granting of licences to selected personnel, and the form of documentation to be approved for licensing of expert training of the selected personnel;

- **SÚJB Decree No 317/2002 Coll.** on type approval of packaging assemblies for transport, storage and disposal of nuclear materials and radioactive substances, on type approval of ionizing radiation sources and on transport of nuclear materials and specified radioactive substances (on type approval and transport), as amended by SÚJB Decree No 77/2009 Coll.;
- **SÚJB Decree No 318/2002 Coll.** on details of emergency preparedness of nuclear facilities and workplaces with ionising radiation sources and on requirements on the contents of on-site emergency plan and emergency rule, as amended in Decree No 2/2004 Coll.;
- **SÚJB Decree No 319/2002 Coll.** on the function and organization of the national radiation monitoring network, as amended by SÚJB Decree No 27/2006 Coll.,
- **SÚJB Decree No 193/2005 Coll.** on the definition of a list of theoretical and practical fields forming the content of education and of training required in the Czech Republic for the performance of regulated activities within the scope of powers of the State Office for Nuclear Safety;
- **Government Regulation No 11/1999 Coll.** on emergency planning zones.

The full text of the Atomic Act including its implementing decrees is available on the website of SÚJB.

The legal framework ends with a number of recommendations and guidelines published since 1978 by the bodies of state supervision of nuclear safety and radiation protection in a special non-periodic edition called “Requirements and Guidelines” available on the website of SÚJB.

Radioactivity in the environment is further mentioned in the following legal documents:

- Act No 254/2001 Coll. on water and on amending certain acts (Water Act);
- Government Regulation amending Government Regulation No 71/2003 Coll. on the definition of surface water suitable for the life and reproduction of the original species of fish and other aquatic animals and on the determination and evaluation of the quality of such water.

These documents regulate the areas directly related to radiation protection in a way that is compatible with EU law.

The following international treaties and conventions, to which the Czech Republic (or, as the case may be, the former ČSSR or later ČSFR) is a party, form a part of the applicable Czech legislation:

- Nuclear Safety Convention (Vienna, 17 June 1994, announcement of the Ministry of Foreign Affairs No 67/1998 Coll.);
- Convention on the Physical Protection of Nuclear Material (Vienna, 26 October 1979, announcement of the Ministry of Foreign Affairs No 27/2007 Coll.);
- Convention on Early Notification of a Nuclear Accident (Vienna, 26 September 1986, announcement of the Ministry of Foreign Affairs No 116/1996 Coll.);
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Vienna, 26 September 1986, announcement of the Ministry of Foreign Affairs No 115/1998 Coll.);
- Vienna Convention on Civil Liability for Nuclear Damage (Vienna, 21 May 1963, ratified, announcement of the Ministry of Foreign Affairs No 133/1994 Coll. correction by way of announcement of the Ministry of Foreign Affairs No 125/2000 Coll.), Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (Vienna, 1988, announcement of the Ministry of Foreign Affairs No 133/1994 Coll.);
- Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage (Vienna, 12 September 1997, signed by the Czech Republic on 18 June 1998, but not yet ratified);

- Comprehensive Nuclear Test Ban Treaty (not yet in force, resolution of the government of the Czech Republic No 535/1996);
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radiological Waste Management (Vienna, 29 September 1997, government resolution No 593/1997, ratified on 26 March 1999);
- Treaty on the Non-Proliferation of Nuclear Weapons (NPT), (decree of the Ministry of Foreign Affairs No 61/1974 Coll. dated 29 March 1974);
- Convention on Supplementary Compensation for Nuclear Damage (Vienna 12 September1997, government resolution No 97/1998, signed by the Czech Republic but not yet ratified);
- Convention on Environmental Impact Assessment in a Trans-boundary Context (Espoo, 25 February 1991, ratified by the Czech Republic on 26 February 1991, the Convention came into force for the Czech Republic on 27 May 2001; announcement of the Ministry of Foreign Affairs No 91/2001 Coll. of international treaties);
- Agreement between the Czech Republic and IAEA on application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (Vienna, 18 September 1996, by announcement of the Ministry of Foreign Affairs No 68/1998 Coll.);
- The Supplemental Protocol to the Agreement between the Czech Republic and the International Atomic Energy Agency on Safeguards, based on the Treaty on Non-Proliferation of Nuclear Weapons (Vienna, 28 September 1999, announcement of the Ministry of Foreign Affairs No 74/2003 Coll.);
- Modified supplement agreement on technical assistance provided by the International Atomic Energy Agency to the government of ČSFR (Vienna, 20 September 1990, announcement of the Ministry of Foreign Affairs No 509/1990 Coll.).

The obligation to report serious events in the area of nuclear safety is also embedded in the bilateral agreements into which the Czech Republic, or its predecessors, as the case may be, entered in the past.

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

Act No 18/1997 Coll. of 24 January 1997 on the peaceful utilization of nuclear energy and ionizing radiation (the Atomic Act) and amending certain acts.

Act No 254/2001 Coll. on water and on amending certain acts (Water Act)

Government Regulation amending Government Regulation No 71/2003 Coll. on the definition of surface water suitable for the life and reproduction of the original species of fish and other aquatic animals and on the determination and evaluation of the quality of such water.

4.1.2 Legislative acts governing NORM, if applicable to Mining Activities

Act No 18/1997 Coll. of 24 January 1997 on the peaceful utilization of nuclear energy and ionizing radiation (Atomic Act) and amending certain acts.

Decree No 307/2002 Coll. on radiation protection, as amended by Decree No 499/2005 Coll.

Act No 254/2001 Coll. on water and amending certain acts (Water Act)

Government Regulation amending Government Regulation No 71/2003 Coll. on the definition of surface water suitable for the life and reproduction of the original species of fish and other aquatic animals and on the determination and evaluation of the quality of such water

The applicant is also obliged to comply with the requirements of other acts, such as:

Act No 44/1988 Coll. on the protection and utilization of mineral reserves (Mining Act);

Act No 62/1988 Coll. on geological operations;

Act No 114/1992 Coll. on nature and landscape protection, as amended;

Act No 183/2006 Coll. on zoning and planning and on building rules (Construction Act);

Act No 17/1992 Coll. on the environment;

Act No 100/2001 Coll. on environmental impact assessment.

4.1.3 List of legislative acts regulating the radiological surveillance of foodstuffs and feeding-stuffs

Act No 18/1997 Coll. of 24 January 1997 on the peaceful utilization of nuclear energy and ionizing radiation (the Atomic Act) and amending certain acts.

Decree No 307/2002 Coll. on radiation protection, as amended by Decree No 499/2005 Coll.

SÚJB Decree No 214/1997 Coll. on quality assurance in carrying out activities connected with the utilization of nuclear energy and activities leading to exposure and on the definition of the criteria for the classification and categorization of selected installations according to safety classes,

SÚJB Decree No 319/2002 Coll. on the function and organization of the national radiation monitoring network, as amended by SÚJB Decree No 27/2006 Coll.,

Government Regulation amending Government Regulation No 71/2003 Coll. on the definition of surface water suitable for the life and reproduction of the original species of fish and other aquatic animals and on the determination and evaluation of the quality of such water.

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

Council Directive 96/29/Euratom laying down basic safety standards for the protection of the health of the workers and the general public against the dangers arising from ionising radiation

International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No 115 IAEA Vienna 1996

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 1990: Recommendations of the International Commission on Radiological Protection, Publication No 60, Pergamon Press, Oxford and New York (1991).

4.2 COMPETENT AUTHORITIES

SÚJB (*Statní úřad pro jadernou bezpečnost*), the State Office for Nuclear Safety, is the competent nuclear authority in the Czech Republic.

The following institutes are under the direct coordination of SÚJB:
- National Radiation Protection Institute (SÚRO)
- National Nuclear, Chemical and Biological Protection Institute (SÚJCHBO)

In addition the following bodies, organizations and institutes are responsible, to a different extent, in the area of radiation protection, particularly with respect to the national radiation monitoring network:

Ministry of the Environment
- Czech Hydrometeorological Institute
- T.G.Masaryk Management Research Institute

Ministry of Agriculture
- State Veterinary Institute
- Czech Agriculture and Food Inspection Authority
- Forestry and Game Management Research Institute
- Central Institute for Supervising and Testing in Agriculture

Ministry of Defence
- Armed Forces of the Czech Republic

Ministry of Finance
- General Directorate of Customs

Ministry of the Interior
- General Directorate of Fire Rescue Service
- Police of the Czech Republic

The responsibilities are defined in the agreements between the central supervisory body (SÚJB) and the ministries defined in the Atomic Act as well as in the agreements between SÚJB and the directly involved institutions of the individual ministries.

These agreements focus primarily on detection and monitoring of radionuclides released from nuclear power plants. For the uranium industry, this activity is carried out by SÚJCHBO.

4.2.1 State Office for Nuclear Safety (SÚJB)

SÚJB (*Statní úřad pro jadernou bezpečnost*), the State Office for Nuclear Safety, is the competent nuclear authority in the Czech Republic and figures 1 and 2 show the position of SÚJB in the structure of state administration bodies and its organigramme.

SÚJB is an independent central state administration body in the area of nuclear safety and radiation protection. In its competencies and powers it is liable neither to the Ministry of Industry and Trade, nor the Ministry of the Environment.

The budget of SÚJB comprises a separate section of the state budget, which is approved by the Parliament of the Czech Republic. The head of SÚJB is the chairman who is appointed by the government of the Czech Republic. SÚJB submits annual reports on the results of its activities to the government of the Czech Republic.

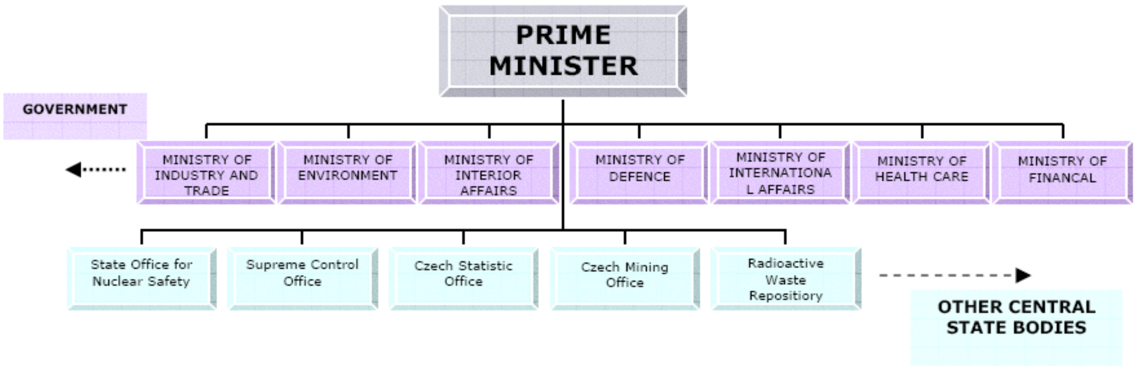

Figure 1: Position of SÚJB in the structure of state administration bodies

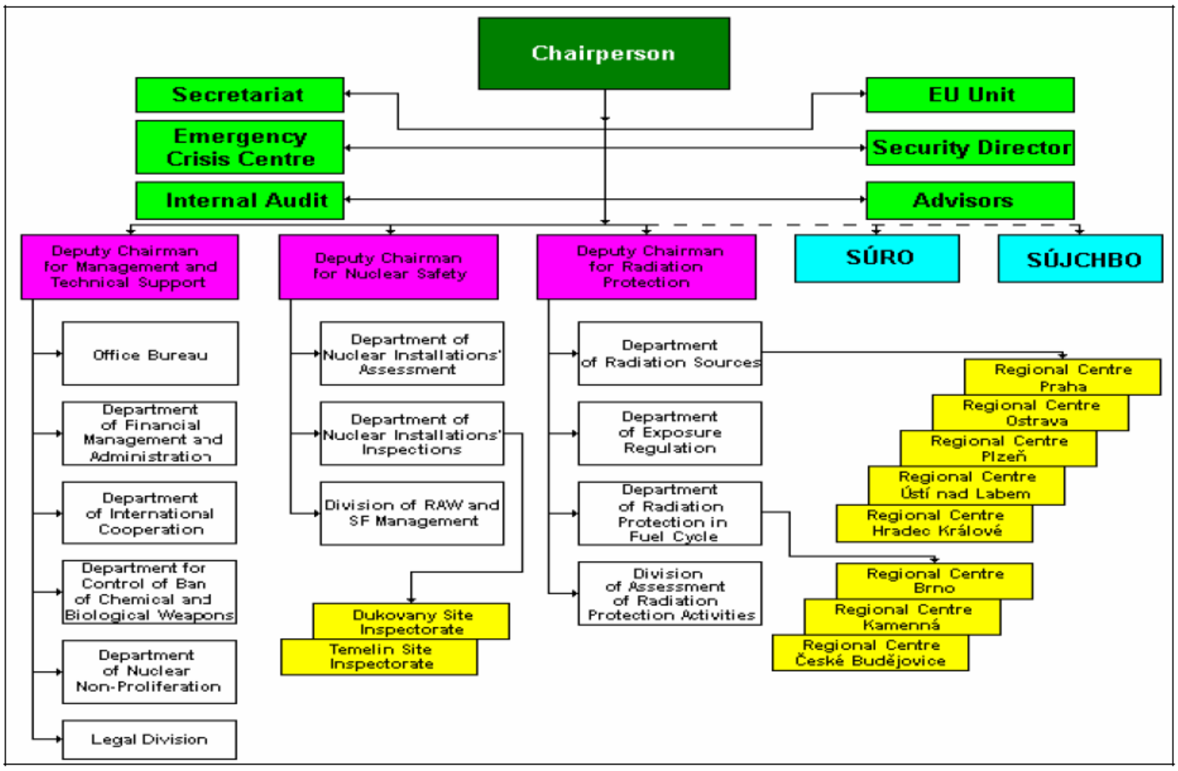

Figure 2: Organization chart of SÚJB

The competence of SÚJB is defined by the Atomic Act, Section 3 of which states that:

(1) State administration and supervision of the utilization of nuclear energy and ionizing radiation and in the field of radiation protection shall be performed by the State Office for Nuclear Safety.
(2) The Office:
a) shall carry out State supervision of nuclear safety, nuclear items, physical protection, radiation protection and emergency preparedness and shall inspect the adherence to the fulfilment of the obligations arising out of this Act,
b) shall monitor non-proliferation of nuclear weapons and carry out state supervision of nuclear items and physical protection of nuclear materials and nuclear installations,
c) shall issue licenses to perform activities governed by this Act and shall issue type-approvals for packaging assemblies for transport and storage of nuclear materials and radioactive substances set forth in implementing legislation, ionizing radiation sources and other products,
d) shall issue authorizations for activities performed by selected personnel,
e) shall approve documentation, programs, lists, limits, conditions, methods of physical protection assurance, emergency rules and, subject to discussion of compatibility with the offsite emergency plan with the relevant Regional Authorities and the relevant Municipal Authorities of Municipalities with extended competence, on-site emergency plans and modifications thereof,
f) shall establish conditions, requirements, limits, derived limits, limit values, maximum permitted levels of radioactive contamination of foodstuffs, guidance levels, optimization levels, reference levels, diagnostic reference levels, exemption levels and clearance levels,
g) shall establish the emergency planning zone and, if applicable, its further structuring, and shall approve definition of the controlled area,
h) shall establish, in accordance with an implementing legal regulation, the requirements on emergency preparedness of the licensees, and shall inspect compliance,
i) shall monitor and assess the exposure status and regulate exposure of individuals,
j) shall issue, register and verify personal radiation passports; related details shall be set out in implementing legislation,
k) shall provide information to municipalities and Regional Authorities concerning radioactive waste management within their territory of administration,

l) shall control the activity of the national Radiation Monitoring Network, the functions and organization of which shall be set out in implementing legislation, shall provide for the functioning of its headquarters, and shall ensure the activities of an Emergency Response Centre and for an international exchange of information on the radiation situation,
m) shall establish state and professional examination commissions for verification of special professional competence of selected personnel, and shall issue statutes for these commissions and specify activities directly affecting nuclear safety and activities particularly important from the radiation protection viewpoint,
n) shall maintain a state system of accounting for and control of nuclear materials and data and information in accordance with international agreements binding on the Czech Republic, and shall set out requirements for accounting methods and inspection thereof in implementing legislation,
o) shall maintain a national system for registration of licensees, registrants, imported and exported selected items, ionizing radiation sources, and a record of exposure of individuals,
p) shall ensure, by means of the national Radiation Monitoring Network and based on assessment of a radiation situation, the availability of background information necessary to take decisions aimed at reducing or averting exposure in the case of a radiation accident,
q) shall approve classification of a nuclear installation or its components and nuclear materials into appropriate categories in terms of physical protection,
r) shall perform the function of the national authority for an international verification of a comprehensive ban of nuclear tests,
s) shall ensure international co-operation within its sphere of competence and, in particular, shall be an intermediary of technical co-operation with the International Atomic Energy Agency, and within its sphere of competence shall communicate information to the European Commission or, if applicable, to other bodies of the European Union,
t) shall decide on assurance of handling nuclear items, ionizing radiation sources or radioactive wastes having been treated inconsistently with rules of law, or where the detrimental condition is not being removed,
u) shall be obliged to provide information according to separate legal provisions and to publish once a year a report on its activities and submit it to the government and to the public,
x) shall exercise the right to express its position on the zoning and planning policy and zoning and planning documentation in terms of safety and radiation protection during activities related to the utilization of nuclear energy and activities leading to exposure.

The Atomic Act stipulates activities which require authorization by SÚJB. In addition to the main permits for placement, construction, operation and de-commissioning, there are a number of other activities such as permit for reconstruction or other changes having an impact on nuclear safety, radiation protection, physical protection and emergency preparedness, discharge of radionuclides into the environment, etc.

SÚJB is also the founding authority and manager of the National Radiation Protection Institute (SÚRO) and National Nuclear, Chemical and Biological Protection Institute (SÚJCHBO).

4.2.1.1 National Radiation Protection Institute (SÚRO)

SÚRO (*Státní ústav radiační ochrany*), the National Radiation Protection Institute, was established in 1995, based on a decision of the chairman of SÚJB. The primary function of the institute is to provide SÚJB with technical and scientific support and special technical knowledge in the field of radiation protection in the Czech Republic.

SÚRO has 2 branch offices, in Hradec Králové and in Ostrava. It also has field offices administered by the SÚJB regional centres in Brno, Ústí nad Labem, Plzeň and České Budějovice.

The following tasks and obligations of the institute are important in connection with this report:

- provision of continuous availability of high-quality laboratory and field measurement capabilities;
- provision of continuous operation of the national radiation monitoring network (RMN);
- data collection from the individual measurement points of the radiation monitoring network;
- management of the information system of the radiation monitoring network (and its central database): verification of quality of the data and analysis of the data;

- organisation of benchmark measurements between the radiation monitoring network laboratory groups which process the samples taken in the environment;
- preparation of an independent audit programme for monitoring of air pollution from nuclear power plants.

This independent monitoring is addressed by the section below.

4.2.1.2 National Institute for Nuclear, Chemical and Biological Protection (SÚJCHBO)

SÚJCHBO (*Státní ústav jaderné, chemické a biologické ochrany*), the National Institute for Nuclear, Chemical and Biological Protection, is a public research institution established by SÚJB pursuant to Act No 341/2005 Coll. in order to carry out research, development and training activities in the field of chemical, biological and radioactive substances and to provide technical support for the supervisory and inspection activities carried out by the Office in the area of radiation protection and inspection of the prohibition of chemical and biological weapons.

SÚJCHBO provides technical support for the supervision carried out by the inspectors of SÚJB in the area of radiation protection at mining facilities with naturally occurring radioactive substances in the Czech Republic. They are mainly the existing or former facilities carrying out the extraction and processing of radioactive raw materials as well as other mines, tunnel and gallery driving projects and similar work using mining methods. They also ensure operation and collection of samples for the radiation monitoring network station in Kamenná.

The activities are carried out by the employees of a separate department of supervision support working in Kamenná and in a field office in Dolní Rožínka.

A substantial part of their activities consists of field measurements of radioactivity, both at the facilities and during the monitoring of the impact of these facilities on the environment. They carry out measurements of dose rates of gamma radiation, volume and equivalent radon activities in the air. This department also collects samples of the air, water and sediments for analyses in the laboratories of SÚJCHBO.

The employees of this department are also involved in the operation of the air control measurement point in Kamenná and they participate in the work of the mobile groups that are integrated in the Radiation monitoring network (RMN) of the Czech Republic. The purpose of this activity is continuous detection of the radiation situation in the Czech Republic.

SÚJCHBO includes an authorized metrological department in the area of measurement of volume and equivalent activity of radon. It carries out inspection and calibration of the instruments used.

Most of the offices of SÚJCHBO are accredited by the Czech Accreditation Agency.

4.2.2 DIAMO state enterprise (DIAMO, *státní podnik* Stráž pod Ralskem)

DIAMO, state enterprise, with the headquarters in Stráž pod Ralskem, is in charge of the uranium ore and, partially, of the coal mining in the Czech Republic (declaration by the government) and ensures production of uranium concentrate for the nuclear energy sector.

4.2.2.1 History of the company

On 23 November 1945, a bilateral inter-state agreement was signed between the Czechoslovak Republic and the Soviet Union on prospecting, mining and deliveries of radioactive raw materials to the Soviet Union.

On 1 January 1946, *Jáchymovské doly* (JD) national enterprise, with its seat in Jáchymov, was established. It was subordinated to the Headquarters of the Czechoslovak Mines within the Ministry of Industry. Headquarters of the national enterprise directly managed groups for prospecting work (revision, search and survey) and for construction and assembly (“Budování” works).

On 2 November 1955, the name Jáchymovské doly national enterprise was deleted and the Central Administration of Research and Mining of Radioactive Raw Materials (in Czech abbreviated as ÚSVTRS) was established as a central body empowered by the competent Ministry. ÚSVTRS’s competence covered mining and processing of uranium on the territory of the Czechoslovak Republic and related building and machine engineering activities.

On 1 February 1958, the Prospecting group within ÚSVTRS was converted to Jáchymovské doly national enterprise – Geological survey, seated in Hluboš, and later in Buková near Příbram.

ÚSVTRS headquarters moved in 1960 from Jáchymov to Příbram, i.e. to the area with the largest mining activities.

On 1 July 1967, Central Administration of the Uranium Industry (which replaced ÚSVTRS from 14 July 1965) was dissolved and an economic organization called Czechoslovak Uranium Industry (in Czech abbreviated as ČSUP), subordinated to the Ministry of Mining, was established.

On 19 October 1989, Czechoslovak Government Presidium‘s Decree no. 94 was adopted concerning the inhibition program for uranium mining and related activities. Based on this Decree, the uranium industry underwent massive restructuring in the subsequent period, which was accompanied by substantial restriction of all activities including production of the uranium concentrate. At the same time, activities which were not directly related to uranium ore mining and processing were privatized.

On 1 August 1991, the seat of ČSUP moved again – this time from Příbram to Stráž pod Ralskem following the discontinuation of uranium mining at the Příbram site.

On 31 March 1992, Concern enterprise ČSUP, Příbram, was renamed to DIAMO, state enterprise, Stráž pod Ralskem.

On 1 January 1993, after the split of the Czechoslovak Federative Republic, DIAMO, state enterprise became a legal successor of ČSUP. The company's privatization and transformation to the market economy continued.

On 1 January 1997, the right to manage the state property of Ostramo Lagoons, Ostrava, was transferred to DIAMO.

On 1 November 2001, the former state enterprise Rudné doly was annexed.

On 1 January 2002, the defunct part of the Ostrava-Karviná mines was annexed to the state enterprise under the name of ODRA.

4.2.2.2 Principal activities of the company

The principal activities of DIAMO are:

- Remediation work, removal of the consequences and the impact of mining and processing of uranium ores, base metals and coal.
- Technical and biological recultivation of devastated properties after decommissioning works.
- Mining activities and activities carried out using tunnelling methods, in particular mining, and processing of radioactive minerals.
- Land-surveying activities.
- Research and hydro-geological exploration works and special works associated with water management.
- Conduct of engineering and industrial constructions with technical equipment including mining activity.
- Administration and management of the state property in the competence of the company.

4.3 LICENSING OF THE DECOMMISSIONING OF MINES AND MINING FACILITIES

The basic legislation regulating the licensing and approval process for nuclear installations and workplaces with ionising radiation sources is the Construction Act (Act No 183/2006 Coll.), the Mining Act (Act No 44/1988 Coll. as amended), the Water Act (Act No 254/2001 Coll. as amended) and the Atomic Act (Act No 18/1977 Coll. as amended). It is also necessary to mention the Administrative Procedures Act No 500/2004 Coll. the State Supervision Act No 552/1991 Coll. and Environmental Impact Assessment Act No 100/2001 Coll. and the decrees implementing them.

According to the Construction Act, the issuing of the principal decision for any construction project involving nuclear installations and ionising radiation sources, i.e. a zoning (siting) permit, falls within the remit of the construction authorities. Other decisions (building permit (construction), occupancy permit (approval of operation), and the decommissioning decision) are currently within the remit of the Ministry of Industry and Trade (MPO) within the transferred competence.

Materials that result from mining operations and subsequently materials and operations within the implementation of the uranium mining phase-out programme (and also ore and coal mining phase-out programme) under the administration of DIAMO, a state enterprise, are governed by legislative acts of the Ministry of Industry and Trade (MIT; *MPO*).

If the proceedings concern interests protected by other specific legislation, such as nuclear safety or radiation protection, the decisions shall be taken by the construction authority in cooperation with, or with the approval of, as the case may be, the relevant state administration bodies which protect these interests. The relevant state administration body may grant its approval subject to the fulfilment of the conditions set in its decision issued in accordance with the particular act which authorizes it to do so. In applies particularly to:

SÚJB, which as the competent state administration body pursuant to Section 3(2)(b), (d) and (o) of the Atomic Act and pursuant to Section 9(1)(1) of the Atomic Act, shall issue a decision regarding:

- management of nuclear materials:
  - category – natural uranium in the form of uranium concentrate,
  - quantity in tons,
  - permitted use, e.g. purchase, sale and storage.
- management of ionizing radiation sources (provision of services to ensure monitoring according to the monitoring programme),
- definition of the inspected zones – deposition of radioactive materials (e.g. uranium concentrate),
- approval of operation and decommissioning of sludge beds, workplaces with very significant ionizing radiation source, decommissioning thereof including disassembly and removal of the structure (i.e. disposal of the free water of the sludge bed, removal of the structure consisting of removal and relocation of the sediments, reclamation, etc.).

SÚJB, as the competent state administration body pursuant to Section 3(2)(d) and (o) of the Atomic Act, shall also approve:

- the classification of the transported nuclear materials of the respective category in terms of physical protection,
- the method of physical protection for the transport of nuclear materials (chemical concentrate of uranium).

The public health protection authority – the competent (regional) public health officer, in accordance with Government Regulation No 361/2007 Coll. which stipulates the conditions of occupational health protection, shall issue decisions, e.g. to determine risk workplaces, and with act No 258/2000 Coll. on protection of public health, as amended.

The competent water authority shall issue, pursuant to Section 104 of Act No 254/2001 Coll. as amended, a decision – approval to discharge water, mine and other water to public watercourses,

The development department of the respective municipal (or higher-level, as the case may be) and the construction authority for the uranium industry shall issue e.g. occupancy permit for structures (or liquidation thereof) within the implementation of the uranium mining reduction programme under the administration of DIAMO, a state enterprise,

The respective regional departments of the Ministry of Agriculture, as the state forest administration body, competent pursuant to Section 14(1) and (2) of Act No 289/1995 Coll. as amended, shall issue approval of the plan for reclamation of land intended to function as forest, e.g. in the case of cessation of chemical uranium extraction at Stráž pod Ralskem.

Other bodies involved include:

- Technical inspection bodies in terms of conventional safety including the safety of pressure components and electrical systems;
- Regional and municipal bureaus in terms of fire safety, waste management;
- The Czech Environmental Inspectorate in terms of protection of the air.

The Construction Act obliges the developer to submit to the respective construction authorities, within the documentation, binding opinions pursuant to separate regulations, in this case the Atomic Act.

The Environmental Impact Assessment Act No 100/2001 Coll. requires assessment of a construction project in terms of its environmental impact (EIA) in a special procedure in which the general public may also participate. This document shall also include the assessment of the radiation risks. Pursuant to this Act, SÚJB is the relevant body which gives comments on the construction project. Under this Act, the public has the right to participate in a public hearing and express its comments on the construction project assessed. The state administration body responsible for the decision concerning the impact of the construction of a nuclear power plant on the environment is the Ministry of the Environment (ME; *MŽP*).

The supervisory body in the area of radiation protection is SÚJB which issues licences for all activities and actions stipulated in the Atomic Act, including but not limited to:

- operation of workplaces for the extraction, treatment and processing of uranium ore
- discharge of radionuclides into water and air
- exemption and clearance of radioactive materials under the Atomic Act
- monitoring of persons and the workplace
- monitoring of the surrounding area
- monitoring of the outlets
- decommissioning of the workplaces

It carries out inspections of the permit holders in the form of, including but not limited to:

- Verification whether the obligations stipulated by the Atomic Act are complied with.
- Approval of the programmes of the licensees in order to assure quality (partially jointly with the Czech Accreditation Institute).
- Approval of the programmes of radiological monitoring prepared by the licensees.

It approves local emergency plans in cooperation with the regional and municipal authorities. Local emergency plans must be related to (and fully in accordance with) the external emergency plans.
It coordinates and controls the activities of the national radiation monitoring network.

The uranium industry workplaces and the radioactive residues produced are considered to be workplaces with ionizing sources of category III according to the Atomic Act.

4.3.1 Decommissioning licence

A Licence for the individual stages of decommissioning of category III workplaces shall be issued pursuant to Section 9(1)(g) of the Atomic Act. The documentation for the licence for the individual stages of decommissioning of category III workplace shall include:

1. evidence of financial coverage of the decommissioning,
2. description of the changes of location due to the operation of a nuclear installation,
3. description of technological procedures designed for the decommissioning,
4. timetable for the decommissioning,
5. method of disassembly, decontamination, alteration, transport, storage and disposal of the parts of the installation contaminated with radionuclides,
6. estimated radionuclide composition and activity of the radionuclides discharged into the environment and the radioactive waste produced,
7. method of radioactive waste disposal, including the storage thereof,
8. limits and conditions for radioactive waste disposal during the decommissioning,
9. safety analyses,
10. scope and method of measurement and assessment of the exposure of employees and persons and contamination of the workplace and its surroundings with radionuclides and ionizing radiation,

11. internal emergency plan,
12. evidence of physical protection of a decommissioned nuclear installation.

The documentation mentioned in paragraphs 8, 10 and 11 shall be approved by the Office.

Approving decommissioning projects does not concern only radiation protection, as described above. It involves other authorities and institutions.

The licence for decommissioning is typically issued together with the licence for discharge of radionuclides into the environment pursuant to Section 9(1)(h) and the licence for management of ionizing radiation sources pursuant to Section 9(1)(i). The documentation required for the issue of these licences is specified below.

4.3.2 Discharge licence

A licence for discharge of radionuclides into the environment shall be issued pursuant to Section 9(1)(h) of the Atomic Act. The documentation for the licence for the discharge of radionuclides into the environment shall include:

1. justification of the discharge of radionuclides into the environment,
2. radionuclide composition and activity of the radionuclides discharged into the environment,
3. evaluation of the exposure of a critical group of the population to the radionuclides discharged,
4. analysis of the possibilities of accumulation of radionuclides in the environment when discharged on long-term basis.

4.3.3 Licence for the management of ionising radiation sources

A licence for the management of ionizing radiation sources shall be issued pursuant to Section 9(1)(i) of the Atomic Act. The documentation for the licence for the management of ionizing radiation sources shall include:

1. justification of the management of the radiation sources,
2. specification of the radiation sources to be managed, their types and accessories,
3. description of the delimitation of the monitored zone (Section 4, paragraph 4, of this Act) at the workplace where the sources will be handled, (diagrammatic drawing) plus information on screening, protective installations and equipment and of the work locations,
4. evidence of radiation protection optimisation (Section 4(4) of this act),
5. evidence of special qualification of the staff performing the operations relevant in terms of radiation protection,
6. programme of monitoring in the scope defined by the implementing regulation,
7. in the cases determined by the implementing regulation a proposal of delimitation of the controlled zone, estimated number of people working there, and method to prevent of unauthorized access to this zone,
8. in the case of management of sources determined by an implementing regulation an internal emergency plan,
9. in the case of expected discharge of radionuclides into the environment or production of radioactive wastes the estimated type and quantity of the radionuclides discharged and the estimated type and quantity of the radioactive waste produced and the method of disposal thereof,
10. in the case of performing tests stipulated by an implementing regulation in order to assess the characteristics of artificial sources evidence of ability to measure and check the characteristics of the ionising radiation sources, proposal of the relevant methodologies and procedures, an overview of the instrumentation and equipment and provision thereof for the performance of the proposed services and, and a concept of the metrological support,

The documentation mentioned in paragraphs 6, 7 and 8 shall be approved by the Office.

4.3.4 Licence for a nuclear installation or a category III or IV workplace

For the issue of a licence for a category III or IV workplace is needed:

1. Expected extent and manner of activities with ionising radiation sources at the workplace, specification of radiation sources to be managed, their types and fixtures and fittings;

2. Description of status of building and installation activities, evidence of the effectiveness of shielding, insulation and protective equipment permitting to start radiation activities;
3. Evidence of radiation protection optimisation (Section 4 para 4 of this Act);
4. Programme of monitoring in the extent specified in an implementing legal regulation;
5. Proposal of controlled area delineation, assumed number of persons working in the area and a method of preventing unauthorised persons from entering the area;
6. On-site emergency plan;
7. Evidence of special professional competence of workers performing activities important from radiation protection viewpoint;
8. Assumed types and quantities of released radionuclides and assumed types and quantities of generated radioactive wastes and methods for their disposal;
9. Proposal of a decommissioning method and estimated costs of such decommissioning verified by the Administration;

4.3.5 Licence for mining and treatment of radioactive minerals

A licence for mining and treatment of radioactive minerals, performed based on and under the conditions of a licence under the Act, Section 9(1) (d) appropriate documentation is needed.

4.3.6 Authorisation for return of land to public use

The basis for authorisation to return land to public use in terms of radiation protection is a decision of SÚJB as the last step within the process of decommissioning. It is issued under the condition that the criteria for surface activities of radionuclides and the dose rate on the surface of the land have been met. The criteria have been set in the decision of SÚJB authorizing decommissioning of the installation. Approval of the return of the land to public use is not just a matter of radiation protection but it concerns many other requirements related to the decommissioning process.

4.3.7 Inspection of such licensed facilities.

The Office inspects entities to which a licence pursuant to Section 9(1) has been granted or which have complied with the reporting obligation pursuant to Section 2(2) of the Atomic Act, entities carrying out operations related to the utilization of nuclear energy and operations leading to exposure which do not require a licence or reporting, entities responsible for preparation or execution of actions aimed at reducing natural exposure or exposure due to radiation accidents, and entities which are reasonably suspected to be utilizing nuclear energy without authorization or carry out operations leading to exposure, and entities which are reasonably suspected to be breaching the obligations under international treaties which are related to the utilization of nuclear energy and ionizing radiation and by which the Czech Republic is bound, and manufacturers, importers and suppliers of construction materials and water.

The state supervision of peaceful utilization of nuclear energy and ionizing radiation, including the penalties, includes:

- supervisory activities of SÚJB,
- remedial measures,
- imposing of fines.

The supervisory activities of SÚJB are regulated in detail by Section 39(1) of the Atomic Act and the State Supervision Act No 552/1991 Coll. as amended. This provides SÚJB with sufficient powers to carry out state supervision and also with enforcement means to enforce the compliance with statutory requirements for nuclear safety and radiation protection.

The staff of SÚJB responsible for the inspection shall be inspectors of nuclear safety and inspectors of radiation protection, appointed by the chairman of SÚJB. They shall work in the headquarters of SÚJB as well as directly in the sites of the nuclear power plants, in the regional centres and in the *workplaces (localities)* of DIAMO, a state enterprise.

The inspectors are authorised, in particular, to:

- enter at any time facilities, installations, operational areas, territories and other workplaces of inspected entities where activities related to nuclear energy utilisation or practices resulting in exposure are being carried out,
- carry out measurements and sampling in the premises of the inspected entities in order to check the compliance with this act and other regulations issued on the basis thereof,
- check the qualifications and special qualifications under this act,
- participate in investigations and clean-up of events significant in terms of nuclear safety, radiation protection, physical protection and emergency preparedness, including unauthorised handling of nuclear items or ionising radiation sources,
- check the compliance with requirements and conditions of nuclear safety, radiation protection, physical protection and emergency preparedness and inspect the nuclear installation conditions, adherence to limits and conditions and service regulations,
- demand evidence of fulfilment of all set obligations for the provision of nuclear safety, radiation protection, physical protection and emergency preparedness of nuclear installations.

Should an inspector identify deficiencies at the premises of an inspected person, he is authorised, depending on the nature of the identified discrepancy, to:

- require the inspected person to remedy the situation, within a set time period,
- charge the inspected person to perform technical inspections, reviews or testing of operating condition of the installations, their parts, system or their assemblies, if necessary for verification of nuclear safety,
- revoke the special professional competence authorisation issued to an employee of the inspected person who has seriously breached his/her obligations or is not fulfilling requirements for qualification and physical and mental capacity,
- propose the imposition of a penalty.

SÚJB is authorised, in the event of a hazard arising from delay or an occurrence of undesirable situations with an impact on nuclear safety, radiation protection, physical protection and emergency preparedness, to issue a provisional measure imposing on the inspected person the obligation to reduce the power output or suspend operation of the nuclear installation, suspend an installation of components or systems of nuclear installations.

4.4 THE NATIONAL MONITORING PROGRAMME FOR ENVIRONMENTAL RADIOACTIVITY

The radiation situation in the Czech Republic is monitored by means of systematic measurements of the dose rate of gamma radiation in the check points throughout the country and by means of measurement of the content of radionuclides in the components of the environment, foodstuffs and feeding stuffs. This system is designed to obtain information for the evaluation of the radiation situation under normal and emergency situations.

The contents, structure and organization of national radiation monitoring network (RMN) are defined by SÚJB Decree No 319/2002 Coll. on the function and organization of the nationwide radiation monitoring network. SÚJB is responsible for the management of the radiation monitoring network. Different ministries are involved in the implementation of the radiation monitoring network. Also operators of nuclear power plants are legally obliged to participate in the radiation monitoring network.

Decree No 319/2002 Coll. specifies that the radiation monitoring network consists of two parts: one which works continuously under normal conditions and one which is activated only in the event of a suspected radiation emergency or during a radiation emergency.

In addition to SÚJB, SÚRO and SÚJCHBO the following bodies, organizations and institutes are involved, to a different extent, in the national radiation monitoring network:

4.4.1 Ministry of the Environment

- Czech Hydrometeorological Institute (CHI, *ČHMÚ*)
- T.G. Masaryk Management Research Institute (*VÚVTGM*)

4.4.2 Ministry of Agriculture

- State Veterinary Institute (*SVÚ*)
- Czech Agriculture and Food Inspection Authority
- Forestry and Game Management Research Institute (*VÚLHM*)
- Central Institute for Supervising and Testing in Agriculture (*ÚKZÚZ*)

4.4.3 Ministry of Defence

- Armed Forces of the Czech Republic

4.4.4 Ministry of Finance

- General Directorate of Customs

4.4.5 Ministry of the Interior

- General Directorate of Fire Rescue Service
- Police of the Czech Republic

The responsibilities are defined in the agreements between the central supervisory body (SÚJB) and the ministries defined in the Atomic Act as well as in the agreements between SÚJB and the directly involved institutions of the individual ministries.

These agreements focus primarily on detection and monitoring of radionuclides released from nuclear power plants. For the uranium industry, this activity is carried out by SÚJCHBO.

The environmental radioactivity monitoring programme was initiated in the late 1950s in response to radioactive fall-out from nuclear weapons tests. Another impulse was the requirement for monitoring of the consequences of the accident at the Chernobyl nuclear power plant. Currently, it reflects the requirements for the fulfilment of obligations of the Czech Republic as a member of the EU (EURATOM).

The radiological surveillance of food stuffs is organised on a national and regional basis, as appropriate.

In the vicinity of nuclear power plants and uranium industry plants, this surveillance is carried out by the operator in accordance with an approved monitoring programme.

SÚJB Decree No 319/2002 Coll. on the national radiation monitoring network (RMN) specifies that two components of the radiation monitoring network deal with measurements of foodstuffs. It concerns contamination measurement points plus laboratory groups which ensure collection of samples from the environment, perform spectrometric and/or radiochemical analyses of these samples in order to determine the concentration of radionuclides in them. Samples of surface water, potable water and foodstuffs are taken and measured. For the surveillance of the neighbourhood of uranium industry plants, this activity is carried out by SÚJCHBO.

4.5 EMERGENCY PREPAREDNESS

Emergency preparedness is not the subject of Article 35 verifications and therefore not described in detail.

Emergency preparedness is based on Decree No 318/2002 Coll. on details of ensuring emergency preparedness of nuclear installations and workplaces with ionizing radiation sources and on requirements for the contents of the internal emergency plan and emergency procedure, as amended by Decree No 2/2004 Coll..

Furthermore, the Government Regulation No 11/1999, on emergency planning zones stipulates that the holder of the licence to place, build or operate a nuclear installation or a workplace with a significant ionizing radiation source shall submit to SÚJB a proposal for determination of geographic definition of emergency planning zone (ZHP) and all actions that the licensee will carry out in the event of emergency (emergency preparedness).

The licensee is obliged to participate, within ZHP, in the facilitation of the national radiation monitoring network. This participation and the related obligations, except those that will arise in the event of an emergency situation, also involve monitoring during normal (ordinary) operation of the installation in question. This ordinary (and continuous) monitoring pertains to the source (radioactive leakage of gaseous and liquid discharges) as well as the impact of the leakage (monitoring environmental indicators).

The purpose of the ordinary monitoring is to prove that the particular nuclear installation is operated in accordance with the requirements for radiological protection of the population and the environment, as provided in the Atomic Act.

5 URANIUM MINING AND MILLING IN THE CZECH REPUBLIC

5.1 INTRODUCTION

The discovery of uranium ore deposits in the Czech Republic took place in the early 1960s. Figure 3 shows the location of the uranium deposits in the Czech Republic.

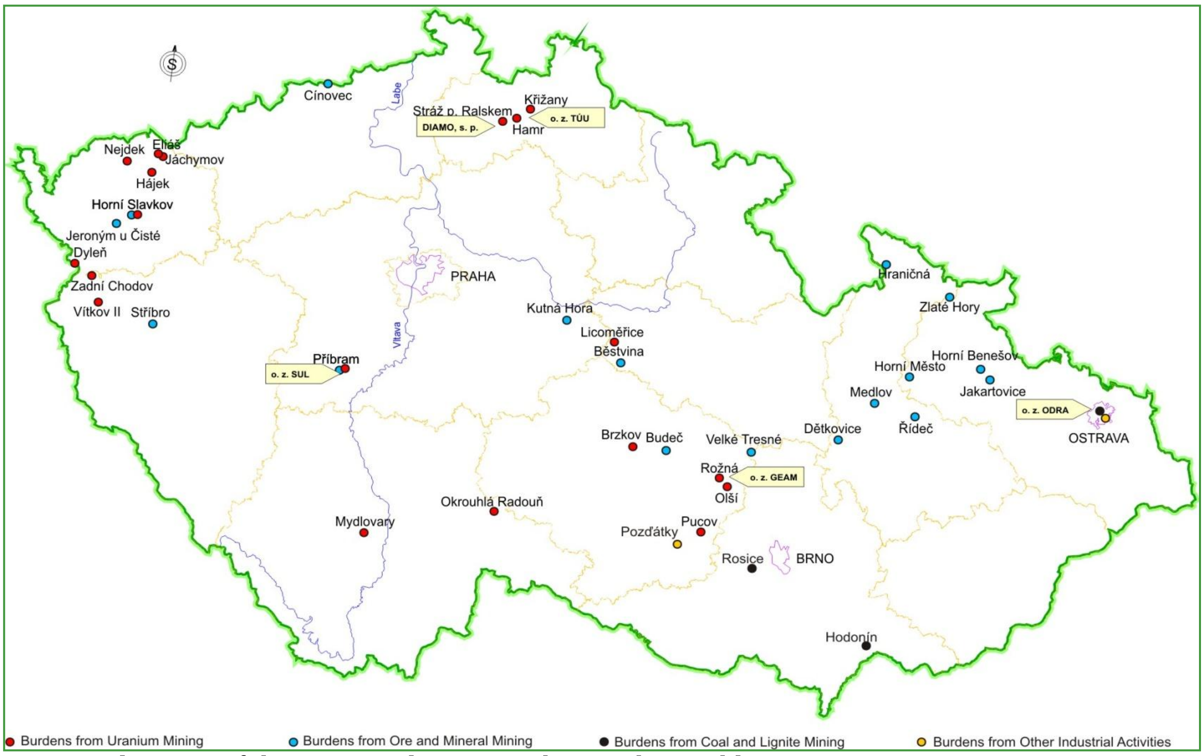

Figure 3: location of the uranium deposits in the Czech Republic.

Uranium mining and processing was the principal activity of the state enterprise *Czech Uranium Industry* (former *ČSUP*; now: DIAMO) from 1946 until the announcement of the reduction programme in 1989.

The verification team learned that from 1946–1956, the production significantly increased thanks to the fast progress of prospecting and the newly found deposits, especially in Příbram and Horní Slavkov. The highest uranium volume (3036 t of U) was extracted at the end of the 1950s. From the beginning of the 1960s, the production has stabilized at ca 2700°t of U.

After 1989, extraction was drastically reduced following the adoption of the reduction programme; in five years extraction fell down to 600°t of U per year.

Between 1946 and 2009, the total uranium production exceeded 110 685 t of U, which ranks the Czech Republic in 9th place among the largest world producers (Canada, USA, Germany, Australia, South Africa, Russian Federation, Kazakhstan and Ukraine).

164 sites with uranium deposits and occurrences were identified and explored in the Czech Republic, and mining subsequently began in 66 of them. The largest uranium deposits were found at Příbram, Rožná, Stráž, Hamr, Jáchymov, Horní Slavkov and Zadní Chodov. In Table 1, the historical uranium production by processing methods is outlined.

Table 1: Review of the Historical Uranium Production by Processing Methods (tonnes U in concentrate)

Processing method	**Total through end of 2006**	**2007**	**2008**	**2009**	**Total through end of 2009**	**2010** expected
Conventional	107 377	263	226	218	108 084	224
In-place leaching [1)]	3	0	0	0	3	0
Heap leaching [2)]	125	0	0	0	125	0
Other methods [3)]	2 340	44	49	40	2 473	25
Total	**109 845**	**307**	**275**	**258**	**110 685**	**249**

[1]) Historical production in the part of the Příbram deposit.
[2]) Historical production in the part of the Vitkov deposit.
[3]) Incl. mine water treatment at the Příbram, Horní Slavkov, Zadní Chodov and Drahonin deposits & environmental remediation at the Stráž deposit (since 1996).

In 1962, a first exploration well HJ-1 was investigated and from 1964 to 1967 major deposits were identified at Hamr, Osečná, Stráž, and Křížany. From 1966 to 1967 first leaching experiments were conducted. In 1974 chemical mining ("in situ" leaching; ISL-methodology) was started at an industrial level. Deep mining started at the Hamr I mine in 1978 and in 1982 at the Křížany I mine. Table 2 presents some key data for deep mining in the Czech Republic.

Table 2: Deep mining in the Shafts Hamr 1, 2, 3, 13; Křížany 4, 5 and Lužice 6, 7, 9

Total length of shafts:	1 448 m
Total length of cross drifts	50 km
Total length of galleries	37 km
Total length of chimneys	8 km
Total amount of mined ore	10 700 000 t
Total amount of produced uranium	11 740 t
Total area of these mines	300 ha
Volume of backfilling	4 963 000 m^3

Chemical mining was performed on a surface of about 6.28 km^2 (628 ha) of land with some 9340 technological wells drilled during that mining period. To perform this ISL mining technology, some 4 100 000 t of H_2SO_4; 320 000 t of HNO_3; 111 000 t of NH_4^+ and some 16 000 t of HF were injected into the layers of uranium ore in the deep soil. In total, chemical mining produced some 15.800 t of uranium between 1974 and 1996.

Figure 4 shows the location of uranium deposits in the area of Hamr – Stráž in the Czech Republic and Figure 5 indicates which mining technologies were applied in these areas as well as the location of the tailings ponds.

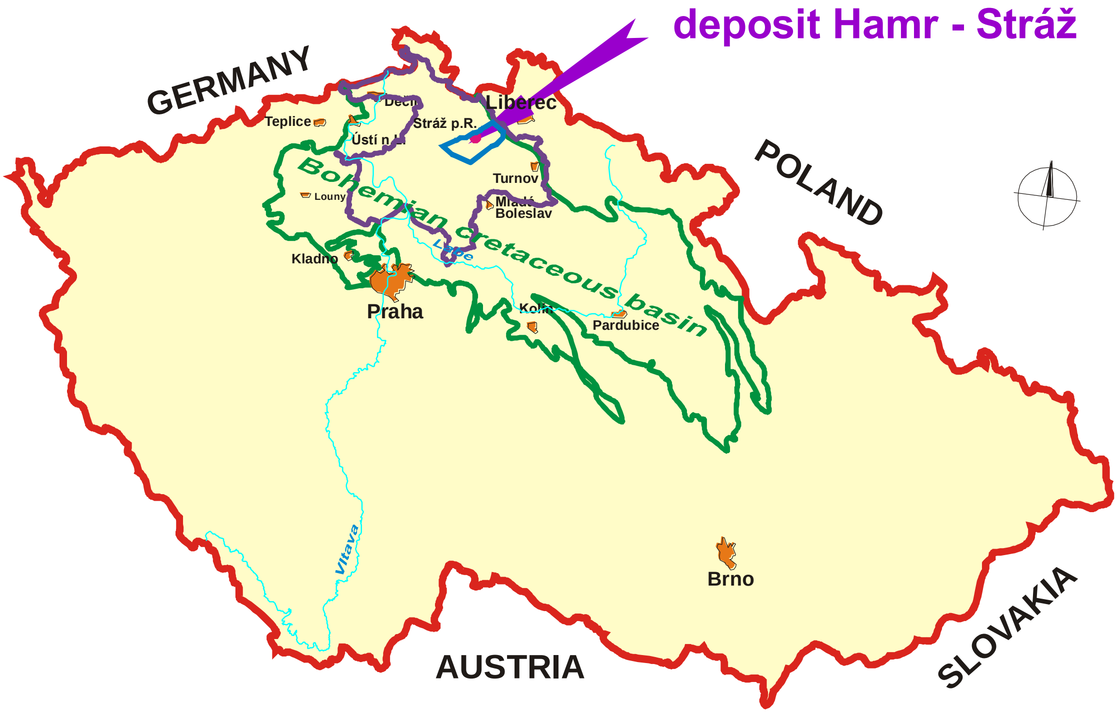

Figure 4: location of uranium deposits in the area of Hamr – Stráž

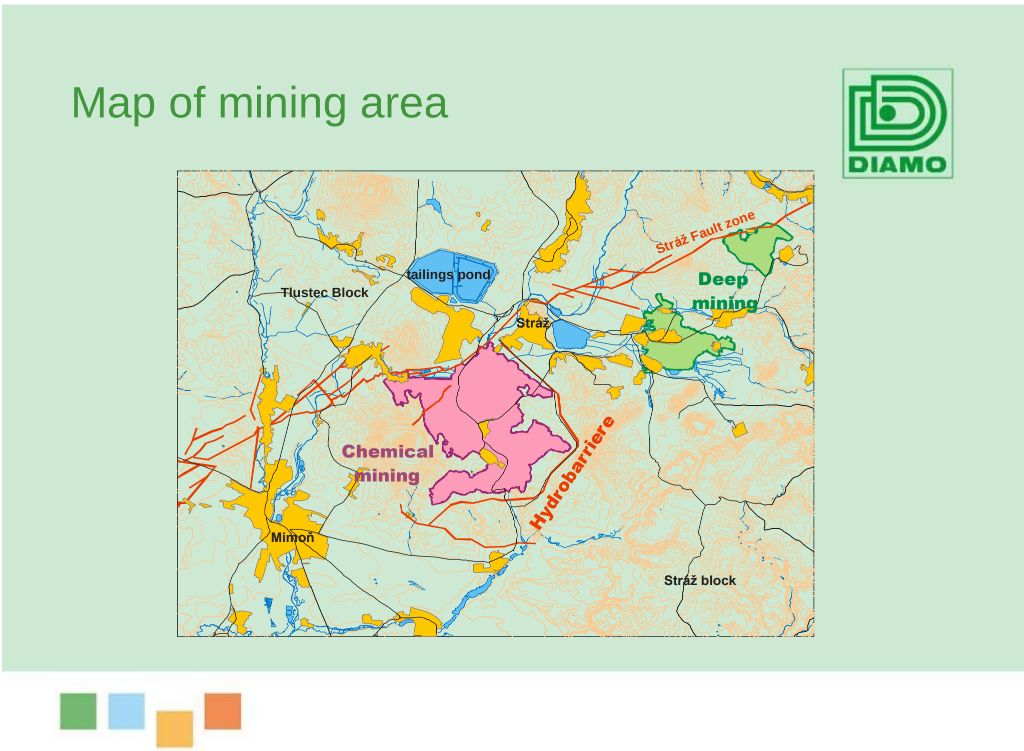

Figure 5: mining technologies applied in the Hamr – Stráž areas

The deep mines of Křížany were liquidated in 2003, those of Hamr in 2004 and chemical leaching was terminated as of 1 April 1996, further to the adoption of two separate resolutions by the Czech Government:

- the Governmental Decree No. 366 of 20 May 1992, determining a transitory period between 1992 and 1994, including the characteristics of special regime of exploitation,

- the Governmental Decree No. 170 of 6 March 1996, presenting the decision on terminating chemical leaching of uranium in Stráž pod Ralskem.

At present, uranium ores are mined and processed in only one conventional deep mine (UG) and mill at the *Rožná* deposit in the Žďár nad Sázavou area, in the Vysočina Region. Mining at Rožná site is projected to a depth of 1200 m, i.e. up to the level of the 24th floor. Uranium ores are processed at the chemical processing plant (alkaline leaching) with storage of sludge at the tailings ponds in place. Production is depending on the uranium resources and will be performed as long as it remains profitable (Governmental Decree No. 565 of 23 May 2007). According to the current evaluation the uranium production is planned until 2012 and eventually until 2013. The expected annual uranium production at *Rožná* is of 224 t of U in 2010.

The team verified another uranium production centre controlled by the state enterprise DIAMO. This centre is at the *Stráž* deposit in the Česká Lípa area, in the Liberec Region. Chemical mining i.e. leaching out of underground uranium by surface bore holes ("in situ leaching" methodology - ISL-) at the *Stráž* deposit is in the process of environmental remediation. Mining by ISL was terminated in 1996. Today, uranium is extracted as a by-product of the decommissioning and remediation programme of the ISL mining. Expected remediation production of uranium at *Stráž* is 12 t of U in 2010.

The assessment of the situation led the Czech government to the decision to terminate chemical leaching as of 1 April 1996 and to start to perform active remediation work.

The reduction programme of the Czech uranium industry has been formally terminated in 2009, but the environmental remediation programme will be on-going for many more years. No further (new) uranium mining activities are in preparation. Table 3 summarises the uranium mining situation until the year 2009.

Table 3: summary of the situation of uranium mining in the Czech Republic as of 1 January 2009)

	Centre #1	
Name of production centre	DIAMO, s.p., o.z. GEAM Dolní Rožinka	DIAMO, s.p., o.z. TÚU Stráž pod Ralskem
Production centre classification	existing	existing
Start-up date	1957	1967
Termination date	ca. 2013	1996
Source of ore: Deposit name Deposit type Resources (tU) Grade (% U)	 Rožná vein 503 0.278	 Stráž sandstone 1152 0.030
Mining operation: Type (UG/ISL) Size (tonnes ore/day) Average mining recovery (%)	 UG 550 95	 ISL -- 50 (estimated)
Processing plant: Acid/Alkaline Type (IX/SX) Size (t ore/day) for ISL (kilolitre/day) Average process recovery (%)	 Alkaline IX/CWG 530 -- 90.5	 Acid IX -- 20000 kl/day --
Nominal production capacity (tU/year)	400	100
Other remarks	Regular mining & milling	U-extraction under remediation process

Acronyms:

- UG - Underground mining
- ISL - In situ leaching
- IX - Ion exchange
- CWG - Crush-wet grind

5.2 URANIUM MINING AND MILLING SITE ISSUES AND SITE DESCRIPTIONS

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, stemming from deep mining activities, 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 to Rn-222, a noble 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 levels defined by the Czech authorities.

Radon and the aerosols emitted into the atmosphere as well as the dust rising from the open, non-vegetated portions of the waste 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 exceeding levels defined by the Czech authorities.

During the course of chemical mining activities (ISL method, mainly acid leaching), several million tonnes of highly concentrated acid have been injected into deep layers of the soil for leaching uranium from deposits of uranium ores with a uranium content of about 0.030%.

The disadvantages of the in-situ leaching technology are:

- the risk of the leaching liquid spreading outside of the uranium deposit, involving subsequent groundwater contamination;
- the unpredictable impact of the leaching liquid on the rock in the deposit;
- the impossibility of restoring natural groundwater conditions after completion of the leaching operations.

A major part of the acid pumped into the leaching fields remains deep in the ground and has led to an important contamination of groundwater. Moreover, in-situ leaching releases considerable amounts of radon, and produces certain amounts of waste slurries and waste water during recovery of the uranium from the liquid.

5.2.2 Non-radioactive contamination

Apart from radioactive nuclides, other waste products resulting from uranium ore production and processing may be observed. 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 (e.g. Mn, Cu, Co, Ni, Cr, As, Hg) from polymetallic and sulphide-polymetallic mineralisations accompanying the uranium mineralisation. 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 levels defined by the Czech authorities. The chemical analyses of the waters flowing out from the mine workings 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 STRÁŽPOD RALSKEM SITE DESCRIPTION

5.3.1 Introduction

The branch plant TÚU at Stráž pod Ralskem (o.z. TÚU) is part of the state enterprise DIAMO, Stráž pod Ralskem. The facility partly produces uranium as a by-product within the remediation programme of the former ISL mining. The branch plant is located in Northern Bohemia about 25 km northeast of Česká Lípa.

In the Czech Republic, in-situ leaching with sulphuric acid was used on a large scale at that site: There the ore deposit is located in Cretaceous sandstones with grades of 0.08 - 0.15% uranium. In an area of 6.28 km^2 (628 ha), 9340 wells were drilled from the surface into the deposit.

The verification team inspected a representative part of this area and received full explanations on how this system was run in the past as well as information on how it is currently used within the remediation programme. The team was impressed by the number of bore holes and tubes all over the ISL mining area.

During the course of chemical mining activities (ISL methodology, mainly acid leaching), enormous amounts (several millions tonnes) of highly concentrated acid have been injected into deep layers of the soil for leaching uranium from deposits of uranium ores. To perform this ISL mining technology, some 4 100 000 t of H_2SO_4; 320 000 t of HNO_3; 111 000 t of NH_4^+ and some 16 000 t of HF were injected into the layers of uranium ore in the deep soil. In addition to the chemicals needed for the leaching operation (including 3.7 million tonnes of sulphuric acid, among others), 100 000 tonnes of ammonium (NH_4^+) were injected; they were a waste product resulting from the recovery of uranium from the leaching liquid.

During the period of chemical mining, leachate was pumped up to the surface and treated by ion exchange chromatography. From this industrial activity from 1967 to 1996, 15 800 t of uranium were produced in the Czech Republic. The major part of the acid pumped into the leaching fields still remains deep in the ground and has led to an important contamination of groundwater. Figures 6 and 7 show the contaminated areas in the region of Hamr – Stráž according to model calculations.

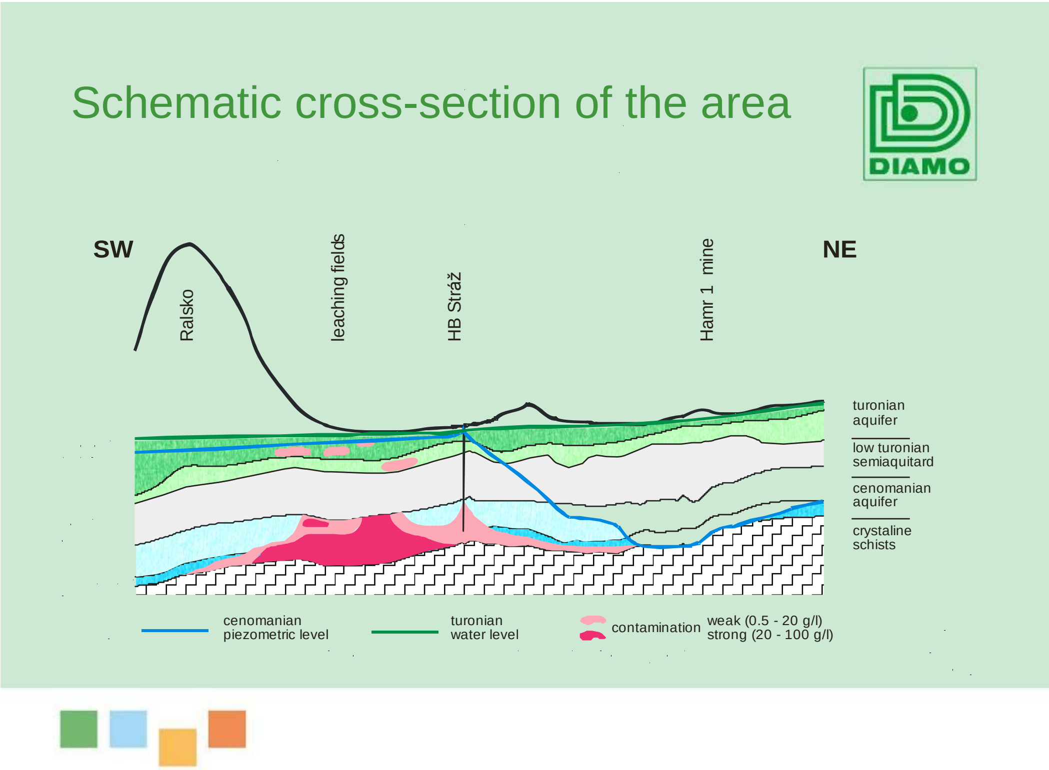

Figure 6: Schematic cross-section of the contaminated area of. Hamr – Stráž

Explanations for fig. 6:

Green: Bohemia Cretacious basin (largest drinking water reservoir in Europe);

Hydrobarrier = hydraulic barrier, HB: barrier to separate deep mining from chemical mining, by injecting liquid;

Turonian aquifer = drinking water source;
Cenomanian aquifer: layer containing U.

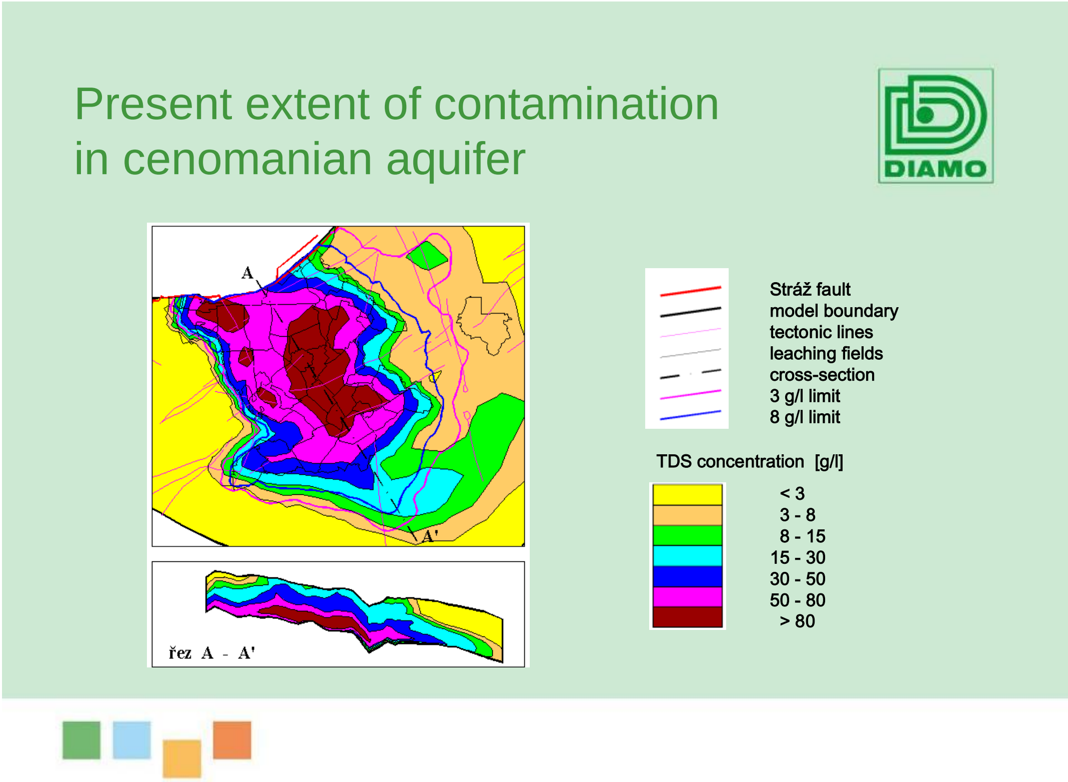

Figure 7: Extent of the contamination in the Cenomanian aquifer in the region of Hamr – Stráž

The team learned that currently, the contaminated groundwater area is larger then 27 km^2. Approximately 99.5% of the total contamination is located in the Cenomanian aquifer with a volume of about 370 000 000 m^3 of groundwater concerned. The total amount of dissolved SO_4^{2+}- is about 3 600 000 tons (of a total of 4 900 000 t dissolved solids). The radiological contamination of this groundwater is similar to the contamination described above for residues with additionally uranium and radium that (over all these years) was leached from the soil by the acid. Moreover, the concerned groundwater is also heavily contaminated by leached heavy metals.

From a (conventional) environmental point of view, the most important contaminants are SO_4^{2-}, NH_4^+ and Al^{3+}.

It is important to note that the northern regions of the Czech Republic are the most important drinking water reservoir of this Member State. Till now the Turonian aquifer is only contaminated to a minor degree (0.5% of the total contamination). This contamination consists of locally isolated plumes (~35 000 000 m^3 with 15 500 t of total dissolved solids). Only the Turonian aquifer is in direct contact with the drinking water reservoir.

It is also important to note that there is no natural "self-remediation" of the contaminated groundwater.

The goal of the approved mining activity of the branch plant TÚU at Stráž pod Ralskem (o.z. TÚU) is not the mining of uranium ore but the remediation of the negative consequences of this activity in the past.

These activities include mainly:

- a progressive decreasing of the concentration of the dissolved chemicals in the rock environment of the *Stráž* deposit, with the goal to avoid that the targeted concentration limits of these chemicals will be exceeded in the Turonian aquifer in future;
- a controlled water treatment in the whole area where the liquidating and remediation actions are performed;
- liquidation and remediation of the tailings pond;

- liquidation of chosen technological, hydro-geological wells and secondary plugging of chosen geological-prospecting wells;
- progressive liquidation of technological equipment of unusable building objects;
- recultivation and incorporation of the whole area into the ecosystems taking into account regional systems of ecological stability and urban plans.

DIAMO - branch plant TÚU at Stráž pod Ralskem (o.z. TÚU) is in charge of the following:

- the abstraction and injection well network;
- the pumping stations;
- the surface technologies for mine water cleaning ('*SLKR I'*, '*NDS 6'* and '*NDS ML'* for removing the dissolved solids);
- a tailings pond (for deposition of the sediments from the neutralisation process and materials from the mining activity);
- the piles of waste rock after termination of the mining activity (five piles assigned for liquidation or recultivation).

The operator, the branch plant TÚU at Stráž pod Ralskem (o.z. TÚU), provides a monitoring of the discharges and an environmental monitoring based on a programme of monitoring approved by the State Office for Nuclear Safety (including establishment of: quantities, as well as all parameters and other facts that are important from a radiation protection point of view).

The monitored objects in this programme are:

- Four points of liquid discharges into surface water (monitored parameters: volume activity of U_{nat}, Ra-226, Pb-210;
- Three points of gaseous discharge into the atmosphere (Monitored parameters: volume activity of long half-life natural radionuclides emitting alpha particles (U and its decay products), volume activity of U_{nat}. Measuring equipment: pump *Quick Take 30* or *PCXR 8*, measuring sets *NRR 610* and *EMS3*; sampling and measuring on the uranium concentrate drying-plant is realized by external co-operator);
- Ten wells for ground water monitoring in the surroundings of piles and of a tailings pond (Monitored parameters: volume activity of U_{nat}, Ra-226.
- Four sampling points on surface water streams (Monitored parameters: volume activity of U_{nat}, Ra-226, Pb-210.;
- Five sampling points of surface water in the area of the tailings pond (Monitored parameters: volume activity of U_{nat}, Ra-226;
- Eight sampling points in surrounding urban areas (Monitored parameters: equivalent equilibrium radon concentration, volume activity of long lived natural radionuclides emitting alpha particles, photon dose equivalent rate. Sampling equipment: stationary dosimeter *ALGADE*. Evaluation is realised by an external co-operator);
- Five sampling points of discharges’ sediments (Monitored parameters: mass activity of U_{nat}, Ra-226. Approx. 1 kg of sediment is sampled. Measurements are realised by an external co-operator);
- Six samples of agricultural products from the surroundings of the branch plant TÚU at Stráž pod Ralskem (o.z. TÚU) (Monitored parameters: mass activity of U_{nat}, Ra-226. Approx. 2 kg are sampled; measurements are realised by an external co-operator).

5.3.2 Reclamation Concepts after In-Situ Leaching

After the termination of in-situ leaching operation on a site, the waste slurries produced must be safely disposed of, and the aquifer which has been contaminated by the leaching activities, has to be restored. The restoration of groundwater is a very tedious process that according to the information given by the Czech experts is not yet fully understood and mastered. So far, it is not possible to restore groundwater quality to the previous condition.

The following provides a description of the handling of waste waters (from mining and production facilities in particular) and of the remediation measures that have been undertaken or are planned at TÚU Stráž pod Ralskem.

- The major objectives of the remedial activities ,schematised in fig. 8 are: to restore the rock environment to a condition guaranteeing a continuation of the usability of the Turonian water of the Northern Bohemia Cretaceous;
- to decommission bore holes and surface installations;
- to incorporate the surface of leaching fields into the ecosystems taking into account regional systems of ecological stability and urban plans.

Ground water (i.e. technological solutions remaining after chemical mining of uranium), mine and surface waters after treatment (cleaning) are discharged to surface water streams taking into account the reference levels approved by the State Office for Nuclear Safety. A part of this water is injected back into the rock environment.

To remediate the in situ leaching zones, the "pump and treat" methodology is used. For this the contaminated Cenomanian aquifer is pumped to the surface, using the existing boreholes and sent to a chemical treatment station where uranium is separated from the extracted Cenomanian solutions using ion exchange chromatography. The resulting uranium 'free' solutions are concentrated by evaporation. The resulting distillate is discharged into the Ploučnice River and the concentrated solutions undergo a crystallisation process, the end-product of which is alum ($NH_4Al(SO_4)_2•12H_2O$).

This alum is currently distributed to external customers for the production of fertilizers.

> *The verification does not give rise to specific remarks but draws the attention of all actors to the fact that "free" Al^{3+} ions formed under acidic soil conditions are known to have a plant toxic effect. The team therefore asks the Czech authorities to investigate the use of alum ($NH_4Al(SO_4)_2•12H_2O$) for the production of fertilisers.*[2]

After crystallisation of the alum, the "mother liquor" is treated in a neutralisation station (station '*NDS 6*' until 2013 and from 2013 onwards the new '*NDS 10*' station) and pumped back into the Cenomanian aquifer. The filter cake resulting from this process is disposed of in the tailings pond.

In 2009, 8 499 684 m^3 of ground, mine and surface waters were pumped to the surface for treatment. Of these, 2 695 830 m^3 were cleaned, 5 011 994 m^3 were injected back into the ground and 3 157 668 m^3 were discharged into rivers.

Technology of ground water cleaning in detail (see also fig. 8):

- *'SLKR I'*: After the uranium separation the remaining technological solution from the Cenomanian aquifer is processed in film evaporators equipped with vapour re-compression. Mine waters – condensate (distillate) after treating – are discharged into surface water streams, eventually they are used as technological water in *'NDS ML'*. A part of the remaining technological solution from evaporators is thinned, processed in *'NDS ML'* and in minimal volume injected back into the ground in the leaching fields area. From the other part of the remaining technological solution from the evaporators, the alum is obtained by a crystallization process in *'SLKR I'*. Alum is distributed to external customers.
- *'NDS 6'*: The water cleaning process in *'NDS 6'* includes a two-step neutralisation of the remaining technological solutions from the Cenomanian and Turonian aquifers, mine waters and surface waters from the tailings pond, by using calcium hydroxide with a dose of barium chloride, followed by sedimentation, filtration and chlorination. Cleaned mine waters are discharged through a retention basin into surface water streams.
- *'NDS ML'*: This technology located in the area of the tailings pond, processes the thickened remaining technological solutions, the so called “mother liquors” from *'SLKR I'*. These remaining technological solutions are in a first step neutralised by lime milk. The precipitated suspension is then filtered using filter presses. After the separation of the sediments the filtrate is alkalised by lime milk in a second step. The resulting suspension is thickened in

[2] *The Czech authorities informed the Commission "that usage of alum has been solved in the Research Institute of Chemical Processes AV ČR(Academy of Sciences), where aspects of alum use were tested and evaluated even as an ingredient in fertilizers with the conclusion, that fertilizers with alum ingredients are not toxically harmful in terms of Al^{3+} contents to plants and other parts of environment."*

sedimentation tanks and then after mixing is passed through filter presses. The filtration cake (the so called "neutralisation sediments") is shipped to and stored in the tailings pond. The ammonia is separated by vapour stripping from the solution stemming from the sedimentation tanks. A by-product of this industrial process is 25% ammonia water (that can be used in *'SLKR I'*; excesses are distributed to external customers. After the whole process the cleaned water is injected back into the ground in the area of the former deep mine.

Remedial measures relevant to the ground water environment represent by far the most important and prime activity of the branch plant TÚU at Stráž pod Ralskem (o.z. TÚU).

The building of the whole complex of surface remediation technologies for ground water cleaning will be finished in 2012 by building and setting to operation of the neutralisation technology *'NDS 10'*.

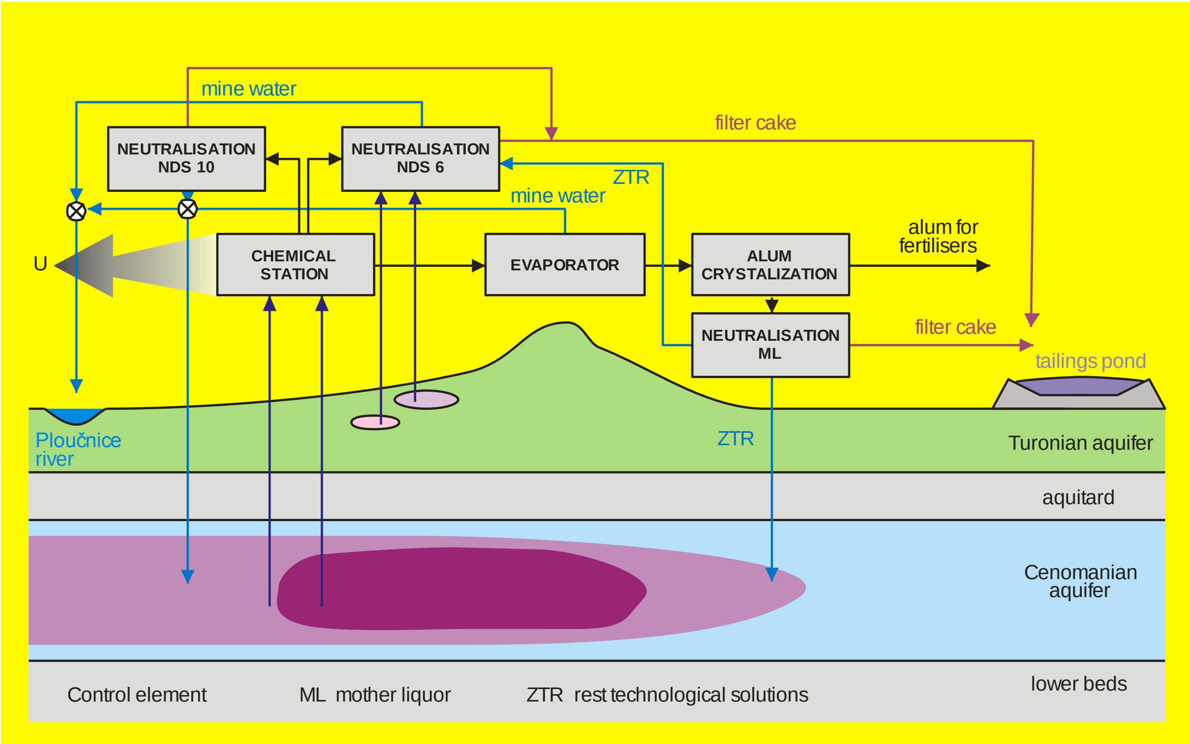

Figure 8: complete schema of remedial technologies (© DIAMO)

The team was informed that the total remediation process is expected to finish in 2035. During this period over 3 000.000 tons of contaminants are expected to be withdrawn from the contaminated groundwater. The total costs for the remediation process are expected to be on the level of 40 billion Kč (1.35 billion EUR).

Decommissioning of chemical leaching of uranium is a long lasting and complex process that must be continuously evaluated and specified. Till the end of the remediation process extensive monitoring, verification and modelling work will be carried out. Respective Czech authorities continuously approve the process of remediation and its individual components.

6 VERIFICATION ACTIVITIES AT URANIUM SITES

6.1 STRÁŽ POD RALSKEM SITE

6.1.1 Injection and abstraction well network

The verification team visited and verified the abstraction and injection well network as well as the pumping stations from which the leachate is pumped to the treatment plant for the removal of uranium (and Ra-226) from the leachate.

The former ISL-leaching field is fenced off and guarded, thus preventing public access to this area. The team was impressed by the industrial size of the ISL extraction field (more than 14 000 extraction wells) and the size of the treatment plant for the extraction of uranium from the leachate. A system of pipes was used for the transportation of the leachate from the extraction wells to the treatment plant; some of these pipes are still functioning. The leachate is thus pumped through these pipes from the extraction site to the chemical station for uranium recovery. This transfer is fully automatic, all data (pressure, etc.) are transferred via radio transmission to the central computer in the control room.

At this chemical leaching site, the uranium containing layers are situated at a depth of about 200 to 260 metres underground which is closer to the surface in comparison to other extraction sites in the region. More than 120 pumps extract the leachate from the soil, each one extracting liquid from up to 260 m of depth (with the "old" air-lift method, from up to 150 m of depth). Such a pump can pump up to 6 m^3 per minute (~ 4300 m^3 per 24 h). The team saw well number 7028 VP-14 that uses a *Grundfos* pump located at -200 m. Some 150 m^3/day are pumped to the surface. For flow rate measurement a *Krohne IFC 010 D* device is used.

The long term goal is to extract and treat the entire volume of the contaminated "groundwater" caused by the former ISL mining methodology. Four times per year the extracted leachate is analysed. Part of the treated water (alkaline solution) is re-injected into the underground after treatment in order to constitute a "hydraulic barrier" between the acidic (leaching) groundwater and the non-contaminated groundwater (see figure 6).

The verification does not give rise to specific remarks.

6.1.2 Chemical Station

The team verified the surface technology installations for mine water cleaning (*'SLKR I'*, *'NDS 6'*) and *'NDS ML'* for removing dissolved solids and received detailed explanations of the removal process of uranium from the leachate. It visited the chemical station (four storey building) with the extraction columns (ion exchange chromatography), the evaporation plant and the uranium crystallisation plant, which leads to the "yellow cake" end-product.

The extracted leachate is first stored in tanks before being passed through the ion exchange columns for sorption of uranium from the solution. There are 6 columns (two of 100 m^3 each (SK6, SK5), two of 80 m^3 each (SK4, SK3) and two of 60 m^3 each (SK2, SK1)). Due to lower flow from the extraction sites, only two columns were in operation at the time of the verification. One of both columns of a pair is used for uranium extraction from the leachate while the other column is undergoing elution of uranium and regeneration of the resin. Samples of the resin from the column are taken at regular intervals in order to determine when the capacity of the column is reached. For resin regeneration and elution of uranium from the columns, a solution of HNO_3 (30 g/l) is introduced to the column from the bottom until all uranium is removed from the column. After this the regenerated column is washed with water and is than ready for reuse. The uranium production through this process is slowing down gradually, due to the fact that the uranium content of the leachate decreases slowly.

For geological reasons, the radium content in the leachate is very low (below LLD), thus not necessitating a special treatment for its removal.

Uranium from the acidic eludate of the ion exchange columns is then precipitated with NH_4^+ ions prior to going to the crystallisation plant where the yellow cake is produced (in a drying vessel; ~220 kg/day) and automatically filled into drums (weight controlled). The drums have a capacity of ~300 kg and are stored in a fenced, locked area of the building. This storage is controlled by EURATOM safeguards inspectors. The team was impressed by the clean technology and the excellent quality of all equipment (most devices in stainless steel) used in this industrial process.

The team were given a presentation of the software *'vp7 R/View SE Client'* showing the schematics of the process.

The team was also informed that a special step to clean the water after the NH_4^+ precipitation of uranium from contaminating Ra-228 was not necessary since the content of that nuclide is below 4 Bq/litre.

The verification does not give rise to specific remarks.

6.1.3 Aerial Discharges

The verification team verified also the aerial discharge point of the "treatment" building (ventilation of the building and aerial discharges from the uranium (yellow cake) drying plant. The ventilation of the drying plant works only when the plant is in operation. This is the case several times a year (six times in 2010). On those occasions the ventilation air is always sampled and measured. Three representative samplings are performed for 20 minutes. Uranium and non-radiological parameters are measured. In 2010, the following values were measured: 5 times <0.5 µg/m^3 air; once ca. 0.5 µg/m^3 air. The sampling (and filter changes) and the measurements of the filters are performed by an external subcontractor. For such measurements this subcontractor connects its air sampler to the aerial discharge tube for 20 minutes. The alarm limit is 0.5 µg/U per m^3. Until now all measurement values were below that level.

The verification does not give rise to specific remarks.

6.1.4 Liquid Effluents (Channel)

The team also verified the monitoring of the liquid discharge point to the Ploučnice River (Code OKC-VS; located a short distance before discharge to Ploučnice River). The flow rate in the discharge channel is measured by DIAMO, the flow rate of the river by the Czech hydrological institute. The team witnessed a demonstration of this water sampling. Every day, the operator takes a sample of 2 to 5 litres to measure uranium and radium (LLD for U ca 0.1 mg/l, for Ra '0.0' – 0.015 Bq/l), some non-radiological parameters are measured too. The discharge limit for U is 0.01 mg/l and for Ra is '0.0' Bq/l.

Sediment sampling is performed once per year by an external firm under contract.

The verification does not give rise to specific remarks.

6.1.5 Alum Crystallisation Plant

The team visited also the "Alum" ($NH_4Al(SO_4)_2 \cdot 12H_2O$) crystallisation plant. This large scale facility is part of the remediation plan of the site. The process was first based on evaporation (started in 1996) and optimised by a crystallisation process (since 2001).

Outside of the facility, the cleaned waters are stored in tanks and are used partly for technological usage (recycling process) or partly discharged to the river. The product is analysed by an external company (*MEGA*), which has an accredited laboratory for this purpose.

The "alum" is transported by truck to the fertiliser production plant (independent company). The alum production is not economically viable but is a part of the remediation process. For the fertiliser production, Al is not separated, but upon request the team was informed that the aluminium content of the finished fertiliser is "below limit".

The remaining "mother liquor" (ML) after the process is a highly alkaline solution. It is pumped back into the chemical mining area in order to neutralise the acidic leachate in the soil (it serves for the immobilisation of uranium in the soil).

At the time of the visit the installation was undergoing maintenance. The team visited the control room and received an explanation of the processes on screen.

The verification team draws the attention of all actors to the potential "plant toxicity" of Al^{3+} ions, especially in combination with acidic rains. It recommends to the Czech authorities to investigate this aspect concerning the content of aluminium in the fertiliser produced and its eventual long term usage in agriculture.[3]

[3] *The Czech authorities informed the Commission "that usage of alum has been solved in the Research Institute of Chemical Processes AV ČR(Academy of Sciences), where aspects of alum use were tested and evaluated even as an ingredient in fertilizers with the conclusion, that fertilizers with alum ingredients are not toxically harmful in terms of Al^{3+} contents to plants and other parts of environment."*

The verification of this part of the remediation process does not give rise to other specific remarks.

6.1.6 Tailings Pond

The team visited the tailings pond. A dam splits the pond into two parts each having a surface of 92.5 ha. The tailings ponds were originally used for the storage of the residues from the chemical treatment of the extracted uranium ores. In a first stage, from 1972 to 1996, 12 millions of tons were deposited (thickness up to 22 metres). Now (second stage), per day 800 m^3 of 'cake' (sludge) from the mother liquor (ML) treatment plant, with a solid content of 50% and a U-238 activity of 50-400 Bq/kg, are transported by special lorries to the tailings pond.

Since the remediation, part of the pond is used in a second stage for the storage of contaminated materials stemming from the remediation activities of the underground mines (building materials).

The tailings pond site has four monitoring points (N, S, E, W) for long lived alpha particles. At the site entrance there is a monitoring point for Rn. In the southern part of the site, there are six monitoring points for groundwater (ca. 16 m deep).

North of the tailings ponds fields are used for agricultural purposes; at three locations samples of agricultural produce (mostly wheat and corn) are routinely taken.

Drainage water from the inner part of the ponds goes to purification, seepage water is piped to the river.

At the time of the visit water covered the central part of the (second) pond. The pond is usually completely dry, the current water volume being due to stopping the technological procedure..

It is estimated that by 2035 (the foreseen end of reclamation work) because of added soil and clay layers the dam surrounding the pond will be about double the current height. The pond will be re-cultivated. Site access will be free, however there will be restrictions for use and monitoring will be in place.

The verification does not give rise to specific remarks. However, the team would like to point out the importance of long term stewardship for the site.

6.1.7 River Water Sampling

Monthly water samples (2 to 5 litres) are taken at six different points by DIAMO (one upstream of the discharge point, the others downstream) on the Ploučnice River (some outside of the fenced area) as well as once a year a sediment sample at the discharge point.

The team visited the sampling location "PLN" (Ploučnice – Novíny); this is the first inhabited location downstream, outside the DIAMO premises. The location is used to calculate the dose for the population from discharge waters. Samples are taken by the operator and – independently on a quarterly basis – by SÚCHBO (on demand of SÚJB) for the regulator.

The verification does not give rise to specific remarks.

6.1.8 Off-site Air Sampling

For determination of the impact on surface air DIAMO set up several integrated *ALGADE* devices (*prelèvement type D, no. D737*) for off-site environmental air sampling. The most distant one (some 9 km East of the site, generally downwind conditions; 'reference point') is installed at Osečná.

The filter heads are analysed for radon (EEC_{Rn}) and long lived alpha emitters (once per month). The TLDs mounted on top of the devices are read once per quarter.

The verification team visited the sampler 032/0025, located at Břevniště, No 57, some 6 km East of the site. The device is mounted on a private building, a contract with the owner has been set up for that purpose. The device is locked, protected by a cage, mounted on a wall of a two-storey building, ca. 1.75 m above ground. A control label read *'verifié 21.3.2006'*, the date *'à verifier'* was not readable.

The verification does not give rise to specific remarks.

6.2 FORMER URANIUM MINES AT KŘIZANY AND HAMR

The team was informed that besides ground water cleaning, the liquidation of the underground mines has been finished. The liquidation of surface plant areas is ongoing. The team inspected the former underground mining sites of the Křizany deep mine. Close to the entrance of the Křizany mine, the team was shown the former "uranium ore storage plateau" of the Křizany mine, which was liquidated in 2009. From here the ore was transported by lorries to the chemical treatment plant (mill). Monitoring of the radioactive contamination along the road was in place. The surface of this storage area was completely removed and disposed of in the tailings pond. Re-cultivation of the area is foreseen for 2011. Slightly uphill of the storage plateau the former mine pile with material not containing uranium ore has already been re-cultivated (larch, birch, pine).

The former Křizany I mine area is protected by a locked fence. The mine was in operation from 1980 to 1990. In 1991, the mine was "backfilled" with concrete and flooded. The underground remediation of the mine was finished in 2004. The winding tower of the mine shaft and part of the buildings have already been removed and disposed of in the tailings pond. Parts of the buildings have still to be removed. Covering of contaminated areas with soil and re-cultivation of the area are projected.

The team briefly saw the former Hamr mine area. The pit head of the mine shaft is still standing; the rest of the site is in a similar state as Křizany I.

The verification does not give rise to specific remarks. However, the team would like to point out the importance of long term stewardship for the sites.

6.2.1 Other tasks of TÚU

The branch plant TÚU at Stráž pod Ralskem also provides a very detailed monitoring of the working environment (personal monitoring and monitoring of workplaces) with respect to the “programme of monitoring of quantities, parameters and other facts important from the radiation protection point of view”, approved by the State Office for Nuclear Safety.

6.2.2 Laboratory at TÚU Stráž pod Ralskem

The verification team visited and verified the operator's laboratory of the branch plant TÚU at Stráž pod Ralskem.

The laboratory has fifteen staff (including the head of laboratory) and is accredited since 2001 by the Czech Institute for Accreditation (ČIA); since 2005, ISO 17025 for 37 methods (incl. Ra, U, gross alpha, gross beta). The authorities perform periodical inspections. Additionally the laboratory is licensed by SÚJB. It is not accredited for the measurement of long lived alpha nuclides (Ra family).

The team was informed that in the first three quarters of 2010 1692 samples and field measurements have been performed.

6.2.2.1 Sample registration

Based on the sample description (sample sheet) by the 'customer' (= DIAMO unit) and on the request for analysis; a manual record book (starting every year again from zero) is kept including the following information (lab number, customer code; date of sample arrival, info if more than one analysis is demanded, info if an analysis by an external laboratory has to be performed, etc.).

These data are also recorded in a data base on a network and are accessible for laboratory staff depending on their function. The data entry is manual with automatic input steps based on the sample sheets. A printout of a working protocol for the laboratory measurements to be performed is made automatically.

The measurement results are introduced by the measuring laboratory into these working protocols, then filled into the electronic system by hand at the registration place. The team noticed that the working sheets were not signed by the measuring laboratory staff. All results are checked and validated by a second person.

The verification team received a demonstration of the registration procedure that in a final step leads to a protocol with all information (two pages).

The labels of the samples arriving for preparation and measurement only contain the laboratory internal number, thus are seen as 'black boxes' with a view not to influence analysis. However, any checks with regard to sample identity are tedious.

> *The verification team suggests exploring the possibility of using a bar code system for sample labelling. This would allow authorised staff members to perform sample checks efficiently.*

6.2.2.2 Sample preparation

U/Ra preparation laboratory

The verification team noted that a very experienced staff member (20 years on the job) is responsible for the task of sample preparation for uranium and radium determination. Any new staff receives on the job training and several months of work under supervision.

The team was shown the preparation method and was given a demonstration of sample preparation for uranium. The laboratory has its own log book for sample arrival.

The written procedure was available in the neighbouring room and is very detailed, accepted by SÚJB.

Various sample types are prepared, e.g. surface and underground water and technological solutions. One method is sorption on silica gel and elution on acetatic acid for spectrophotometric measurement. The detection limit achieved for uranium is 0.01 mg/l, for Ra-226 0.03 Bq/l. More than 1953 uranium analyses (including for monitoring) are performed annually.

For each sample one single person is responsible for the whole sample analysis routine (sample preparation to measurement).

> *The verification team suggests having the sample preparation procedure available at the work place in order to avoid delays or mistakes when preparation is performed by less experienced staff.*

6.2.2.3 Devices

- For the various measurements (including long lived alpha determinations) the laboratory has a set of devices available: *EMS3* (for radium measurements) with *TEMA MC1256* as backup
- *TESLA NGR610* for alpha-beta measurements
- Portable dose rate meters *RODOMETR DC-3E-98* (old Czech device) and *RADOS RDS-110* (new Finnish device)
- Alpha contamination monitor *RP 103D* (78 cm2 surface), with scintillator
- Radon monitor *Genitron AlphaGuard*

The Czech Metrological Institute frequently performs checks of the equipment.

The team noted an air sampler *ALGADE 'préleveur Type D'* with a TLD on top in a waterproof cover. All devices are supplied with data sheets.

For uranium measurement a *Lange DR5000* spectrophotometer is used; the manual is available at the workplace, notes with the results are made by hand.

After each U sample reference material is analysed to check system stability. Each sample is analysed twice: if a difference occurs the measurement is repeated; if the difference is too large the whole process is repeated; in such a case the situation is discussed with the technical head who decides what to do. In such a case also a uranium standard is measured and the results kept in a data base as proof.

Generally, results are taken from the measurement log and manually transferred to a working sheet, then transferred to a data base for printout for the customer or other reporting.

The analyst signs in the log book, the validator on the working sheet.

The *EMS3 alfa-beta-automat* includes a 2x20 sample changer. After each set of 20 samples two reference samples and background blinds are measured. Reference samples are produced in the same way as real samples using distilled water and a standard with known concentration; they are produced for each series.

Once every two years the device is calibrated by the Czech Metrological Institute.

The team noted that the samples are very well prepared with a very smooth surface. This serves to guarantee a stable counting efficiency, in particular for alpha measurements.

A demonstration of a radium sample preparation was given using $BaNO_3$ respectively $PbNO_3$; after precipitation (24 hours) the sample undergoes centrifugation (*Heraeus Multifuge 3S*).

The laboratory uses *Plastibrand®* pipettes; it also has a *Memmert* dryer (with temperature calibration label).

The verification does not give rise to specific remarks.

6.2.2.4 Tracing, quality management and reporting

The verification team asked to trace measurement results and for this purpose chose a sample 'surface water downstream, May 2009'. The working record (entry: result 2.5.2009, code OKC-VS, lab nr 1626 showed a value of 0.02 mg/l, the working protocol (hand written) 0.016 mg/l. The information was immediately ready from the paper archive (the original is sent to the customer).

The whole site has a quality management system, compatible with ISO9001, according to the decree 132/2008Sb, with periodical inspections by internal and external auditors.

Besides accreditation analysis quality is assured by duplicate samples. traceable standards from the Czech Metrological Institute, reference material, and participation in national inter-comparisons (organised by the Research Centre for Water Quality).

Data handling/reporting generally has the following steps: the values from the measuring equipment are transferred to the working data sheet from where they are transferred to the working record (respectively the certificate of test or the certificate of dosimetric measurement). All data are stored in a data base, with daily backup. All results also exist in printed form (one for the customer, one copy stored at the laboratory).

Annual reports containing e.g. information on staffing, work place, discharge, environmental monitoring results, evaluation) are to be sent to SÚJB before 1 March each year; when approved by SÚJB the report is published on the internet.

The verification does not give rise to specific remarks.

6.3 DOLNÍ ROŽÍNKA (SOUTH-EASTERN CZ)

6.3.1 *Rožná* mine background

The region of the eastern part of the Czech-Moravian Highlands ("*Českomoravská vrchovina*") was included in the programme of geological exploration works in 1954 when the first evidence was acquired that the uranium ore mineralization in this region would probably be of industrial significance. In the summer and autumn of 1956 the deposits of *Rožná* and *Olší* were discovered.

Geological exploration work started quite intensively and its climax was the commencement of the first investment project, which was the extraction shaft R 1 at the *Rožná* deposit in October 1957. The experimental exploitation of uranium was carried out that year based on the geological exploration work carried out by means of underground mining.

In 1958 the mine plant called *Karel Havlíček Borovský* (R I) was established already on extractable reserves of uranium. On 2 January 1959 the management unit "National enterprise *Jáchymovské doly Rožná* was created with registered offices in Dolní Rožínka. The Olší plant was established in 1959, an independent mine plant R II (*Jasan*) was established in 1962. From the period 1962 - 1963 the production in the mine plants has been consolidated, and the exploitation in the deposits continued intensively until 1988. In 1989 the *Olší* deposit was closed and the reserves of uranium at the *Rožná* deposit were gradually re-assessed in order to achieve higher economical efficiency. To date over 1/5 of the entire production was exploited in the region of Dolní Rožínka, which is more than 22 500 tons of uranium.

Together with the fulfilment of tasks during the extraction and processing of uranium ore, the GEAM division in Dolní Rožínka also managed to carry out remediation and reclamation work including:

- Complete remediation and reclamation of the *Olší* mine, including the mine water treatment plant;
- Commissioning of the *Licoměřice* mine water treatment plant;
- Commissioning of the *Běstvina* mine water treatment plant;
- Commissioning of the extended capacity of the settling pit water in the Chemical processing plant.

6.3.2 Basic data and milestones in the history of the Rožná region (Dolní Rožínka)

1954 Commencement of geological work in the vicinity of the deposits of the ore field of *Rožná – Olší* (radiometric anomaly discovered)

1955 Execution of geological-exploration work

1956 Discovery of the *Rožná* deposit (mineralization in the geological-exploration trench)

Discovery of the *Olší* deposit (mineralization in the geological-exploration trench)

1957 Commencement of exploitation at the *Rožná* deposit (within the national enterprise of *Jáchymovské doly Trutnov*) – driving of shaft R 1,

Experimental exploitation from the geological-exploration work

1958 Establishment of the mine plant *Rožná I* (*Karel Havlíček Borovský*)

1958 Delivery of the reserves of uranium of the south section of the *Rožná* deposit (as of 1 January 1958)

1959 Commencement of exploitation from the sections *Rožná I* and *Rožná II* (start of excavation of shaft R 2)

1959 Establishment of the *Olší* plant

1963 Establishment of the independent mine plant *Rožná II* (*Jasan*)

1964 Construction of the radiometric processing plant R I

1965 Commencement of construction of the chemical processing plant for uranium ore in *Dolní Rožínka (*1964 – decision on the construction)

1966 *Jáchymovské doly* name changed to *Uranové doly n. p. Dolní Rožínka*

1967 Achievement of the highest exploitation of uranium ore in the region – 693 300 tons of ore per year

1968 Completion of the construction of the chemical processing plant in *Dolní Rožínka*

1968 Commencement of comprehensive and systematic cleaning of mine water

1984 Migration of the ventilation system of *Rožná I* and *Rožná II* mines to suction system

1987 Commencement of inhibition of the uranium ore mining in the former Czechoslovakia

1989 Termination of operation of the *Olší* mine plant, commencement of liquidation of the *Olší* mine

1990 Achievement of the deepest level at the *Rožná* deposit (extraction shaft R 6S on the 26^{th} floor level -702.4 m below sea level)

1992 The existing name *Uranové doly Dolní Rožínka*, division changed to *GEAM* division *Dolní Rožínka*

1995 (1 July) Termination of operation of the *Rožná II (Jasan)* mine plant – by merger with the *Rožná I* mine plant

1996 Start of operation of the mine water treatment plant at the Olší deposit

2002 Completion of the remediation and reclamation at the *Olší* mine

(as of 1 January 18.1 ha of forest in the cadastral area of *Olší* and *Drahonín* transferred to the state enterprise, *Lesy ČR*)

2007 Commissioning of the extended capacity – settling pit water and mine water treatment plant within the chemical processing plant

2007 Resolution of the Government of the Czech Republic No. 565 dated 27 May 2007 approving continuation of mining and processing of uranium in the *Rožná* deposit as long as economically effective

Based on the study of distribution of uranium mineralization within the Bohemian massif, it was mainly Moravian ore region that was defined in the Moldanubian zone. It includes deposits which have been subject of exploitation of the *GEAM* division *Dolní Rožínka* (*Uranové doly Dolní Rožínka*). It includes mainly the deposits of *Rožná*, *Olší*, *Slavkovice - Petrovice*, *Jasenice - Pucov* and *Javorník* in the Rychleb mountains and also the so-called deposits of the Elbe line, *Licoměřice* and *Chotěboř*, exploited for a short time by the division (including the *Trutnov* coal basin where the division was exploiting in 1957 - 1964). The deposits *Rožná*, *Olší*, *Slavkovice - Petrovice* form the ore field of *Rožná - Olší*. All deposits are located in the district of Žďár nad Sázavou (since 2004 the *Olší* deposit is located in the district of Brno - Venkov).

Table 4 shows details regarding the exploitation in the area of *Dolní Rožínka*, figure 9 the geographical locations.

Table 4: Exploitation in the area of *Dolní Rožínka* - dates of start and termination of exploitation, and percentage of the exploited U-metal

Deposit	Beginning of exploitation	End of exploitation	Volume of exploitation of the U metal (%)	Total depth of the deposit (m)
Rožná	1957	-	82.4	1200 (geological)
Javorník	1958	1968	1.8	350 (geological)
Olší	1959	1989	15.1	750 (geological)
Slavkovice	1964	1970	0.5	250 (geological)
Other *	1957	1965	0.2	

* Other deposits - *Jasenice - Pucov, Licoměřice, Chotěboř, Trutnov* – coal

Fig. 9: Location of the main uranium deposits - GEAM division Dolní Rožínka and the chemical processing plant

The *Rožná* deposit is located 50 km – 60 km northwest of Brno, 3 km from the nearest railway station Rožná.

By way of decision of the District Mining Authority of Liberec No. 2056-02-Šk/96 of 10 December 1996 the exploitation area of *Rožná* was reduced to 876 ha 40 a and 54 m^2. It is located in the cadastral area of the following municipalities: Horní Rozsíčka, Bukov, Milasín, Rodkov, Horní Rožínka, Blažkov, Dolní Rožínka, Rožná. Exploitation of the deposits mainly affects the municipality of Dolní Rožínka and slightly the municipality of Bukov. The *Rožná* exploitation area does not interfere with the developed parts of other municipalities.

It is a low-temperature hydrothermal deposit with ore bodies located in dykes and mylonitized and cataclastic zones. The gradient of the zones and dykes ranges between 50° - 80°; the direction of the tectonic faults is very close to that of folic-acid rocks and if approximately north-south. The uranium mineralization consists primarily of uraninite ($UO_2.UO_3$) and coffinite ($USiO_4$). In the depths of the deposit the uranium mineralization is bound in complex silicate compounds where the uranium minerals are of very small size (additives of Zr, Ti). The ore bodies have an average thickness of 2.5 m (sometimes up to 8 m) and an area of tens of hectares.

At the *Rožná* deposit, the rock complex consists mainly of a diverse set of the rocks of the Stráž Moldanubian zone. They include biotite-plagioclasic gneiss, amphibolites with inserts of lime silicate rocks and marble (these rocks form the adjacent rick massif).

The *Rožná* deposit is cut through with shafts (R 1, R 2, R 3, *Bukov*, R 4, R 7S) located in the bedrock of the main ore-bearing structures, open on the individual floor levels which are located approximately 50 m vertically from each other. There are 24 floor levels open in the deposit (the exploration shaft R 6S is extended to the 26th floor level).

Beneath the 24th floor level, only the shaft R 6S is made, from which the 25th and 26th floors were supposed to be extended (in 1988 the construction was stopped after the breakup of the shaft station on the 26th floor level). Only shaft stations are therefore broken up on the 25th and 26th floors.

The total length of the shafts, including the ventilation shafts, is 6690 m. The maximum achieved depth is 1200 m below the surface. The floor development cross tunnels were driven from the individual shafts, making the ore bodies in the zones or dykes accessible. Vertical distance of the floors is approximately 50 m. Development of the deposit to the depth progressed gradually, as the mineralization development was specified in more detail by means of the mining work. A system of so-called supporting floors driven in advance with depth difference of 150 m has proven to be practical for the geological exploration. These floors allowed for detailed exploration of the prospective parts of the deposit. Only after having evaluated these works were the floors located between the last extraction floor and the supporting floor developed.

The floors are extended from the main cross tunnels by directional crosscuts in the bedrock of the zones, from which short excavations crossing the ore structures are driven. The horizontal distance between two adjacent excavations is typically 50 m - 60 m.

The calculation of the reserves in the extraction area of 8.76 km^2 was made as of 1 January 2006. The extraction works are directed in the 20th, 21st and 22nd floor, reserves of uranium are also on the 23rd and 24th floor of the shaft R 7S. A total of 18.223 tons of uranium has been exploited as of that date; balance reserves of U-ore are approximately 680 t. Development and preparation of reserves on the 23rd and 24th floor level started in 2007.

6.3.3 Extraction of Uranium Ore from Underground Mines

Two basic extraction methods, or their individual variations according to the specific conditions, were used for the exploitation of the deposit. The difference between the individual variations of the two basic methods is determined particularly by the different preparatory works on the block (location of the raise in the zone or its bedrock, location of the inter-floor driving openings, etc.).

Firstly overhand working with filling of the stopes which consists of ascending mining (from the bottom floor towards the top floor) of the extraction area by means of horizontal ladders (benches) with a height of 3 m with timber support and filling of the stopes. The spatial definition of the block is determined by the height of the floor and the gradient of the ore zone (dike) and the directional distance between the floor driving openings, i.e., 50 - 60 m. The basic dimensions of the block are therefore 60 - 65 m (height) by 50 – 60 m (length). Block raises are pre-driven (or driven at the same time as extraction) in the boundaries of the block; they are always shared by two adjacent blocks; an auxiliary raise can be made between them in the middle of the block as the extraction proceeds, serving mainly for the drawing of the broken rock. The support is made of wooden timber settings (half-settings); own backfilling is used, i.e., acquired within the stope block, particularly by driving timber drifts to the overlying rock. With respect to the method of acquisition of the backfilling, its nature is one of a technological backfilling (the extracted benches are back-filled, but free spaces are made in the overlying rock by means of driving of timber drifts). The backfilling makes it possible to use this extraction method also for extraction below still non-exploited reserves but it has no significant impact on the process of loosening and top-slicing of the overlying rock and on the signs of extraction on the surface.

Secondly downward top-slicing stoping under an artificial ceiling which consists of downward mining (from the top floor towards the bottom floor) of the extraction block by horizontal benches with a height of 3 m under an artificial ceiling. The stopes are back-filled with the fall of the enclosing rock. The spatial definition of the block is again 60 - 65 m (floor height) (after the dip of the zone) by 50-60 m (length), and the floor-driving opening is located in the middle of the block. The boundaries of the adjacent blocks are typically located in the half distance between the floor driving openings. The block is prepared for extraction by driving the central block raise from the floor opening from the lower floor to the upper floor. After having extracted the bench, the width of which depends on the process of mineralization, an artificial ceiling is placed on the levelled footwall, made of round timber and wire netting. The fall of the enclosing rock is caused by the destruction of the wooden supports of the bench (using a blasting operation). For thickness over 4 m the bench is divided into strips having a width of up to 4 m, which are worked and gradually caved in from the overlying rock toward the bedrock.

6.3.4 Chemical Processing Plant

6.3.4.1 Conditioning of ore

To process the ore from the *Rožná* deposit, the *Olší* deposit (see 6.4) and other deposits a chemical processing plant started operation in Dolní Rožínka in 1968. The chemical processing plant uses alkaline leaching of uranium ore.

The extracted ore from the *Rožná* deposit mainly contains the following minerals: biotite, feldspar, quartz, pyrite, chlorite, argillaceous minerals, graphite, carbonates. The uranium minerals are present in the ore in the oxidic form - uraninite, and in silicate form as coffinite. The ore also contains complex silicates.

Chemically, the ore contains uranium in the hexavalent form (well leachable) and tetravalent (leached after oxidation by oxygen from the air).

The broken ore is swept from the receipt yard by a bulldozer to a grating where the remainders of wood and larger pieces, if any, are separated. After having fallen through the grating, the ore is transported by a system of conveyor belts to the ball mills where the incoming ore is milled into particles. For this, two-stage milling is used, using four *GM27* ball mills. Each mill is equipped with a spiral classifier which ensures the circulation loading of the mill. For milling, residual water from the sludge thickeners (water recirculation) is added. Copper is added (to the milled ore in a defined proportion) in form of waste material with a suitable copper content or directly in form of copper sulphate as a catalyst of the leaching process.

After this milling process the ratio between the solid and the liquid phase is 1 to 6

In a thickening process, the proportion of the solid and liquid phase of the incoming sludge from the milling process is brought to a ratio of 1 to 1 before the sludge undergoes the leaching process.

To speed up this process polyacrylamide, is added as a flocculation agent, directly to the incoming sludge. Water deficit is replaced in this process primarily by the cooling water from the evaporator, drainage water from the mud settling pit etc.. In the circuit the water of these thickeners and the clarified water of the thickener after alkaline leaching are mixed.

6.3.4.2 Leaching (Alkaline atmospheric leaching)

Alkaline atmospheric leaching by soda takes place in 7 in-line columns having a total volume 580 m^3. The thickened sludge with a density of approximately 1450 g/litre is pumped – after an addition of soda to achieve a concentration of 23 - 26 g/litre – to two pre-heaters where it is heated to a temperature of 60 - 65°C. From the pre-heaters the sludge is pumped to the cascade of the leaching columns which are stirred by airlifts (using air with pressure 0.20 – 0.25 MPa). Temperature in each column is automatically controlled at 85°C. The waste vapour from the leaching is used for pre-heating of the incoming sludge. The first column is fed with soda and ammonia. Ammonia gas together with copper forms a tetra-ammocupric complex, which is the catalyst for the leaching process.

The time of retention of the sludge in the leaching process is approximately 50 hours.

The leached sludge is pumped from the last leaching column to the sorption line. The sludge is cooled in two coolers. From the last leaching column, 50% of the leached-out sludge flows to the sorption line.

The other 50% are returned to the dedicated thickener used prior to the leaching process. Here, after washing and cooling by the technological water (wastewater from thickeners before leaching) together with the additive deficit water, the sludge is thickened with an addition of a flocculation agent and fed back to the leaching line. The purpose of this operation is to utilize the residual concentration of soda and to save heat for pre-heating of the sludge.

6.3.4.3 Sorption

Uranium is adsorbed in two parallel sorption lines comprising 8 columns each. The sorption process is based on a strongly basal anion exchanger (*Varion AP*, at 30 -35°C) using the Resin-in-Pulp (RIP) technology in counter-current configuration.

Before entering the sorption, after separation of splinters of wood, the sludge is thinned with the drainage water or, if applicable, with water from the settling pit or clean service water to a ratio of 1to 3 (solid to liquid).

The flow of the sludge and the resin is counter-current (RIP technology). The stirring and movement of the two phases takes place in the columns by concentrically placed airlifts equipped with drainage systems for separation of the sludge and the ion exchanger.

Retention of the sludge in the sorption is approximately 4 hours.

The remaining sludge and liquid phases having both a minimum concentration of uranium after the sorption process, are deposed in the settling pit K I.

The ion exchanger charged with the adsorbed uranium is pumped by the airlift pump (special pump) to the elution line. Particles of the ore stuck to the anion exchanger are washed.

6.3.4.4 Elution

Elution of the saturated exchanger occurs on two pulse columns by washing off the sludge from the ion exchanger (RIP technology) at a temperature of approximately 30 - 35°C. The washing-off is ensured by a system of rotary screens with streaming. During this operation the ion exchanger poisoned by polythionate and sulphur is regenerated by application of ammonium sulphide. The salts of the elution solution are removed from the eluted ion exchanger before another sorption cycle in a column streaming. To remove the ion exchanger poisons from the resin, a corrective regeneration of the ion exchanger by nitric acid is used. The time of retention of the ion exchanger in the process of elution is 8 - 10 hours. After the washing off, the sludge is pumped to the settling pit.

Uranium is precipitated by ammonia from the solution (eluate), after alteration of the pH to < 3.5 by concentrated sulphuric acid. Then the precipitated ammonium diuranate is separated from the solution by sedimentation in a circular thickener (volume 120 m^3), vacuum filtering or, if applicable, by centrifugation. The precipitated ammonium diuranate is subjected to washing by caustic soda with subsequent filtering, reducing the content of molybdenum and fluorine to the prescribed qualitative limit (Mo $< 0.3\%$, F $< 0.1\%$). Then it is washed by acidified mine water and normal mine water. After washing, the uranium concentrate is gas dried, sampled and dispatched to the customer.

The final product is ammonium diuranate $(NH_4)_2U_2O_7$ with a concentration of approximately 65 - 73% U.

The verification team, after these explanations visited the installations and witnessed the process paying particular focus to the associated environmental aspects.

6.3.5 Tailings Ponds

Milled ore, from which uranium was removed, is deposited in tailing ponds in the form of tailing sludge. Both the tailings ponds K1 and K2 were originally of the valley type, however the tailings pond K1 has been reshaped with the construction of a circumferential dam. The dam of the K1 tailing pond is waste-rock-fill bulked, without any sealing, heightened step by step with dams 3.5 m high. Heightening dams are founded on deposited sediment. The area of the tailings pond K1 is 640 000 m^2, height of the dam is 50 m. The area of the tailings pond K2 is 270 000 m^2, height of the northern dam is 30 m, height of the southern dam is 20 m. The dams of the tailings pond K2 are constructed with inner asphalt-concrete sealing and concrete grouting into the underlying rock.

The tailings ponds are protected against afflux water by catch-water drains. The original creek, going through the valley of the tailings pond K2, has been diverted with an adit that is 500 m long with a flow rate of 13 $m^3\ sec^{-1}$. Seepage water from the tailings ponds is collected by drainage and pumped back to the system.

A new concept of heightening the dam has been applied according to the expected close-down of production. The inner part of the pond has been divided with dams in the sedimentation part (sections) and water accumulation part (central part of the tailings pond). Inner dams are constructed parallel with the circumferential dam at a distance of 20 m. The space between the circumferential dam and the inner dams is filled with the pulp. The central part will be used as free capacity for free water during the remediation.

The verification team, after these explanations visited the tailings ponds and the monitoring of these areas (air monitoring using *ALGADE preleveur type D* devices – change of sampling head every three months; gamma dose rate, TLDs, groundwater, seepage water, etc.). Both the processing plant and the tailings pond K1 are protected by fences. Tailings pond K2 has been partially remediated and only a small area of water remains. On the other hand the larger tailings pond K1 is still in operation. (An interesting feature was the presence of solar energy panels around the pond, though these belong to a separate company.)

> *The verification does not give rise to specific remarks. However, the team would like to point out the importance of long term stewardship for the site.*

6.3.6 Discharge management and control

There are four water and four air discharge paths in operation and monitored at the *Rožná* mining site. These concern the discharge of decontaminated mine waters from two water treatment plants belonging to the *Rožná I* plant, discharge of treated sewage waters from the chemical treatment plant and discharge of treated tailing pond waters. The air discharges are: *Rožná I* mine ventilation, the chemical concentrate drier, air from the ore mill and KI and KII tailings ponds.

The air sampling from each individual operation is conducted in the approved system of monitoring sites. *ALGADE* aerosol sampling devices are used to conduct this kind of sampling, with an average flow rate of 80 l per hour and consisting of the sampling system, supply block, flow meter, display package and detection head. The filters are removed on a monthly basis and then sent to the National Institute for Nuclear, Chemical and Biological Protection laboratories in Příbram-Kamenná to be processed.

The verification team visited a number of monitoring points in the general mine area, in particular the *ALGADE* dosimeters in the area of the K1 tailings pond and the ventilation shaft R 6. The team noted during the visit to the main water treatment plant that there was a stop valve in place to immediately stop discharging if abnormally high levels were detected.

Aerial discharges

The mine uses an under-pressure air system with a *VCD 31.5 M* main ventilator (rotor diameter of 3.15 metres) located on the surface of the ventilation shaft R 6 with energy input of 1.0 MW. The fresh air enters the underground by several shafts (B1, B2, R1, R3, R7S) at the rate of 220 cubic metres per second. The fresh air is in the mine led via crosscuts and airways, which is caused by depression of the main ventilator. Ventilation pipes with independent ventilators, blow fresh air right to the work place.

Used air flows away from the places of work via mined out spaces and via specific mine works to upcast crosscuts and further to upcast shaft R 6. The whole air system of the mine is controlled and checked by a computer.

Currently, investigation levels for discharges to air from the mine are set in the range of some 45-100 µJ/m^3 (latent energy of radon decay products). Investigation levels for discharges to air from the chemical treatment plant are set in the range of some 0.6 Bq/m^3 (uranium).

Liquid discharges

Water pumped from the underground is contaminated by uranium and radium. The environmental protection lies in consistent refining (decontamination) before release. The average yearly volume of purified water from the mine is approximately 1.6 million cubic meters.

Purification of contaminated waters from the mine is based on precipitation of uranium and radium in a physical chemical process using ion exchangers in the decontamination facilities. The radium settles as precipitate in the de-sludging pool and uranium is processed in the chemical processing plant as chemical concentrate.

The processing plant was foreseen to use a close water cycle technology with a balanced or rather losing water system. However, about 300 000 m^3 of water, mainly drained groundwater and precipitation, enter the water system each year independently of the processing plant. This water is partially bonded as moisture in deposited pulp. Water content of the yellow cake is 37.5%. Water overflow with high content of salts has to be treated and released into the surface water.

Because of the separation of uranium through ion-exchange it is also necessary to ensure removal of sulphate anions from the system as they negatively influence the efficiency of the sorption process.

The method of evaporation was chosen for water treatment synchronised with the crystallisation of anhydrous sodium sulphate. A parallel-flow eight-stage evaporating unit with forced circulation has been put in operation with the last two stages allocated for continuous crystallisation of sodium sulphate.

The method of electrodialysis and reverse osmosis were tested and put in operation for desalination of technological waters because of high consumption of energy of the evaporating unit. The rounded-off system has been generated by connecting electrodialysis, reverse osmosis, evaporating unit and uranium production from which the following ecologically safe products are released:

- anhydrous sodium sulphate used for laundry agent production;
- condensate that is, after desorption of ammoniac by air and treatment on cation exchangers, released to the surface water and partially used for vapour production;
- diluate and permeate that are released to the surface water.

Installation capacity:

total volume of treated water:	450 000 m^3 per year
evaporating unit:	210 000 m^3 per year
electrodialysis, reverse osmosis:	220 000 m^3 per year
exchangers:	20 000 m^3 per year
sodium sulphate production:	7000 t per year

The verification does not give rise to specific remarks.

6.3.7 Remediated areas

The verification team was given an initial presentation, including a short film outlining the history of the site covering the mining, processing and remediation of closed sites. Thereafter the verification team extensively visited the site, with particular focus on the processing plant, tailings ponds, and remediated areas. Both the processing plant and the tailings pond K1 are protected by fences. In the processing plant all aspects of the process were shown and detailed explanations given for each part of the process, with a particular focus on the associated environmental aspects. Tailings pond K2 has been partially remediated and only a small area of water remains. On the other hand the larger tailings pond K1 is still in operation.

6.3.8 Site specific Environmental Monitoring

'Environmental impact monitoring' for the *Rožná* mining site is conducted according to the operating procedures "Discharges monitoring" and "Surroundings monitoring" that are approved (from the radionuclide monitoring point of view) by the State Office for Nuclear Safety. Any new requirements from the State authorities such as issued decisions, permissions and statements are included in the documents when revisions are made.

While performing the surroundings monitoring, the water quality in 13 profiles of surface waters is also supervised as well as in six wells in the neighbouring villages and 57 monitoring boreholes adjacent to the tailings pond. The quality of fluvial sediments is monitored in two profiles of the *Nedvědička* stream.

In order to assess the radiation burden for the population resulting from activities of *DIAMO* other values are also taken into account besides the typical ones, like for example the measured data of compound volumetric activity of long lived radionuclides from the uranium-radium range of alpha emitters and equivalent volumetric activity of radon.

Eleven *ALGADE* stationary dosimeters have been installed to check the atmospheric air quality (five in the vicinity of the source of contamination and six in the neighbouring villages, respectively), also TLD detectors are in operation and dust fallout is monitored near the transportation route of the uranium ore. Soil contamination is measured along the transportation route of the uranium ore and the agricultural crops are analysed in the neighbouring villages.

Apart from the above-mentioned monitoring there is additional monitoring of ecosystems (geobiocenosis and hydrobiocenosis) carried out in test areas by the Institute of *Geonics AS CR* Ostrava at the *Rožná* mining site, that also goes for environmentally significant segments of the region in the area of interest. The Faculty of Natural Sciences at Masaryk University in Brno performs hydro-biological monitoring of the *Nedvědička* and *Rožínka* streams.

In addition to a number of TLD detectors the team also saw a number of boreholes used for monitoring in the vicinity of the K1 and K2 tailings ponds.

The verification does not give rise to specific remarks.

6.3.9 Operator's lab

The verification team visited *SZLAB* (*Středisko zkušebních laboratoří*), the laboratory contracted by the operator, *DIAMO-GEAM*, to perform the necessary analyses.

The laboratory holds ISO 17025 certification for all environmental analyses carried out. Whilst the majority of samples analysed are on behalf of *DIAMO* the lab also carries out work for other parties and their competences extend beyond the range of analyses which were examined in the context of the present verification.

The sample receipt room also serves for washing of sample bottles for re-use. Receipt confirmation is issued for all samples received. Complete details of each sample, including the analyses to be carried out, are input to the laboratory computer which attributes a unique identification number.

LABSYS LIMS software is used for management of samples and analyses.

Alpha and beta activity is analysed using a 32 position *EMS 3* device with 2 times 1000 seconds measuring time using methane as the counting gas.

A *Hach DR4000V* spectrophotometer is used for U measurements in water.

Heavy metal determination is done using a *Varian Spectra AA220* atomic absorption spectrometer.

For measurement of organic substances a high-resolution gas chromatograph *Fisons HRGC Mega 2* is used.

For sample preparation the laboratory has a *HS31A* oven and two centrifuges (*MPW 350e* and *Universal 32*).

For all instruments there was a detailed operating procedure nearby.

All analyses must be approved before input to the *LABSYS* system which is used since 2002. Data is stored locally on the lab PC and a backup is created on a special dedicated server for the lab.

Additionally lab staff carry out on the spot gross alpha activity measurements in the mine, essentially to protect workers' health.

The verification does not give rise to specific remarks.

6.4 OLŠÍ MINE

Whilst the verification team spent more time at the active mine and associated treatment plant they also visited the closed *Olší* mine and in particular the water treatment plant which uses an ion exchanger for purification of waste water arising from the mine shafts.

The *Olší* mine consisted of 11 levels and extended 900 m below the surface but all shafts have now been closed using waste rock, with the exception of one shaft which has been left open to allow water to be pumped to the surface. The mounds of waste rock on the surface were reshaped, covered firstly with sludge from the tailings pond followed by 50 cm of soil. The area was planted with coniferous forest, which is widely seen in the region. After a period of 5 years when the trees have become established the management of the site will be handed over to the Czech Forestry Department. Waste water, containing uranium and additionally having a high iron content continues to be treated. It is hoped that after +/- 50 years contamination will have fallen below discharge limits and that it can be discharged directly. Currently the ion exchange resin is changed every 14 days. Owing to the build up of radon in high concentrations within the treatment plant the doors remain open. However this is not feasible in cold weather so an *Atrea Duplex S-B 2000* system has been installed to extract the radon from the air.

The verification team recommends thorough investigations with regard to long term stewardship of the remediated sites. It draws the attention of the authorities to the fact that deep rooting trees may deteriorate the soil cover.

7 REGULATOR'S TASKS

7.1 GENERAL

The State Office for Nuclear Safety provides the state supervision in the field of radiation protection, licences activities and releasing of radio-nuclides into the environment, approves QA programmes and monitoring programmes and provides inspections.

7.2 SÚJCHBO

The verification team visited and verified the laboratory of the National Nuclear, Chemical and Biological Protection Institute (NBC; *Státní ústav jaderné, chemické a biologické ochrany, v. v. i.*, SÚJCHBO) at Příbram-Milín-Kamenná.

It attended a presentation with regard to all tasks of the institute (including Fire Rescue Services and the Chemical Weapons Convention). All kinds of experiments (incl. with radioactive material) can be done at this location, with flexible approaches and quick reaction to events. A heliport is available on the premises for fast transports.

For 'nuclear' tasks some 15 staff are employed (incl. part time personnel).

7.2.1 Sample registration

Based on the samples and the sample sheets, an internal laboratory number (starting with 'one' each year) is allocated to each sample and introduced into the registration book, which contains information on the sampling date, sample taker, who accepted the sample at the sample reception, the material to be analysed, the amount of sample, the required analysis, who requested these analysis, (and later) the name of the analyst and the date of analysis. At the time of the visit the internal number was 593. The radiological laboratory deals with a few dozen samples per month, including samples from private customers and industry. The data are not registered in a computer system.

An internal guidance book for surveillance work (work programme) is available in the laboratory. The team received it together with a list of results for the Stráž region.

> *The verification team suggests using electronic tools (data base, LIMS) for sample registration and sample data management.*

7.2.2 Analysis tasks

Uranium measurement

The verification team noted the presence of an old *Jarrell Ash* fluorimeter (*Fisher Scientific Co.*) for uranium measurements. It was told that the new *ALGADE* device will replace it for the routine tasks. Calibration labels (for *ALGADE* dated 16.12.2009) and check labels (for *Jarrell* dated 14.12.2008) were issued by the Czech Metrological Institute (*Český Metrologický Institut* - *ČMI*).

The working procedure (accredited method according to standard *ČSN 83 0533*) was available.

Alpha / beta

A *Tesla* low level alpha - beta counting assembly (counting gas methane from *Linde*) is available with a *ČMI* check label from 2008.

Standards used are Am-241 for alpha and KCl for beta determinations. Standards and background are measured before and after each series (generally every day). For SÚJB only alpha measurements are performed. The team noted that the beta-standard is not very homogeneous, however such analysis are not performed with regard to uranium site monitoring.

For radium measurements, the laboratory uses a *TEMA Praha / JKA 1100* device with a detector *NS9502E* and a *JKA 300* device (including an RS-232 interface) with a detector *NS9502E*; both have *ČMI* checks dated 5.1.2010.

An *EMS3 alfa-beta-automat* (*ČMI* check date 14.10.2010) is also available, as is a *TESLA* automatic alpha beta counting system (*ČMI* check 14.10.2010).

The laboratory has UPS to maintain the measuring devices operational in case of power losses.

Results are transcribed into a measurement log book using a hand calculator for any calculations (no complex calculations are needed), then are typed in a Word document on PC. The head of this part of the laboratory validates the input.

Scales

A *Mad'arsko LB-1050/1* scale (with *ČMI* label) is used. Two other scales (*Chirana A3/200*) are not in use anymore.

TLD

Currently some 600 personal dosimeters are analysed per month and some 30 environmental dosimeters per quarter.

The laboratory formerly had a French TLD system, but due to problems switched to the Finnish *RADOS* system, which is seen as being more sensitive and of better use for the institute.

The team noted a *Harshaw TLD 3500* reader with PC for data handling; the *ČMI* check label dates from 2.2.2010.

The procedure was available. The team received a demonstration of the operation of the device. Every day for control three irradiated TLD tablets (irradiation with Ra source at location) are analysed.

For service / repair of the reader a contract with the Czech *Harshaw* representative is in place.

A muffle furnace for annealing the TLD tablets (10 min at 240°C) is available; annealing is checked by measurement of ten tablets of each batch (240 tablets).

Field measurement devices

The verification team was shown several measuring devices for use in the field: for radon determination a pump (*SKC QuickTake 30*) and a *MAAF (1997)* device for measuring Rn EEC is used; the *ČMI* verification label shows 3.2.2009. The procedure is available to go along.

For gamma dose rate a *Thermo ESM FH40G* device (*ČMI* label 14.12.2009) can be used.

Additionally there is a mobile set consisting of an *Exploranium GR-135 Identifier* plus *Garmin* navigation system and PC with presentation of data and data transfer to SÚJB and SÚRO (*ČMI* label 19.1.2009). The device belongs to the regional centre of SÚJB (which is located in the same building as the SÚJCHBO radiological laboratory), but is used by SÚJCHBO (each regional centre of SÚJB has such a device). Exercises and training with the equipment are performed every month.

Etching room

For etching purposes two devices are installed, one for environmental and one for personal films.

The laboratory uses *Kodak CR115* (due to bad experience with *CR39*: the alpha tracks being nearly indistinguishable from dust tracks). Etching takes approximately two hours. For controls films are irradiated with Am-241.

Track Etch 'Reader'

The team was shown the procedure for reading track etch films for radon analysis. Currently this is done only for personal dosimetry (the devices having the same type of sampler head as samplers for environmental tasks).

For track analysis a first selection is performed on the microscope display, which sector on the film should be chosen for further counting, relying heavily on the personal experience of the (only) person doing this job. Then the tracks are identified 'by eye'. To the team this seems a tedious task and the staff member is not young anymore.

> *The verification team recommends exploring the possibility of using an automatic reader system, in particular to allow more objective track identification and to avoid the physically stressing task of reading tracks 'by eye'.*

Gamma spectrometry

For high resolution gamma spectrometry SÚJCHBO has a HPGe (*Canberra*, 33% rel. efficiency, 1.91 keV resolution; the data sheet was not at place; the *ČMI* label showed 19.2.2008). The shield consists of Pb rings with a 10 cm Pb sliding cover. NIM electronics is from *Canberra*, the MCA is *Canberra Series 35plus* (operator manual is at place). Spectrum analysis is on PC with software *GAMAT* (© Jan Matzner 2000, using *Canberra Genie 2000 Ver 4.0*). Mr. Matzner is now employed at SÚJB and thus would be still available for any problem solving.

Samples analysed are sand, sediments and dried foodstuffs, the geometries calibrated being 500 ml Marinelli beaker and Petri dish.

Calibration sources used are Am-241, Eu-152 and Cs-137 in liquid (Marinelli beaker geometry, dating from 22.9.1988).

Energy checks are performed once per week, background determinations once every one to two months.

Archiving of spectra is on CD-ROM (after having problems with 3.5"HD diskettes).

> *The verification team suggests analysing the long-term stability of the spectra archiving method – e.g. vulnerability of CDs – and eventually exploring the usefulness of an external hard disk.*

Several UPSs are available for guaranteeing electric power.

Filling of the detector dewars with LN_2 for cooling is three times per week. Several LN_2 dewars are available as reserve.

Radon chamber

The verification team was show a large radon chamber, completely new equipment, still in the test phase. It will be used for calibration of radon detectors by the end of 2010 (currently the old one is still in use).

The device is similar to the equipment at PTB in Germany (one of the leading radon analysis institutions world wide).

The device is up-to-date, specially constructed for SÚJCHBO, with a display e.g. showing the schematics. It is programmable, can control Rn daughters, and allows calibration of dosimeters and detectors at radon concentrations of up to 2 MBq/m^3.

The verification does not give rise to specific remarks.

7.2.3 Quality control, reporting

The (radiological) laboratories have all accreditations: ČSN EN 110/IEC17025:2005, valid until 31.12.2014; controls by the Czech accreditation authority are every one to two years.

The measurement results are handed over to the customer in form of a protocol (computer printout).

The verification does not give rise to specific remarks.

8 NATIONAL MONITORING SYSTEM

The verification teams verified part of the national monitoring system for environmental radioactivity (Radiation Monitoring Network, RMN), in particular some sampling and gamma dose rate monitoring stations in the vicinity of the uranium sites visited, and some regional centres of SÚJB. Some aspects of the national monitoring system had also been touched upon during the Article 35 EURATOM verification in 2005.

8.1 SURFACE-WATER SAMPLING: ELBE RIVER AT DĚČÍN-LOUBI

The verification team witnessed a demonstration of surface-water sampling at the Elbe River at Děčín-Loubi, ca. 10 km upstream of the German border given by a staff member of *Povodí Labe, státni podnik* (Hradec Králová) that is responsible for surface water sampling and analysis in this region.

A stainless steel bucket, a stainless steel filter funnel and a labelled flask were used. A five litre sample was taken for alpha/beta measurements. The bottle was labelled: 'RCH596'. A one litre sample was taken in a *Kautex* bottle to be used for H-3 determination. The bottle was labelled: 'Tr48'. All labels had been pre-prepared in the laboratory prior to the sampling campaign. A link between the sampling data and the flask label exists in the log book.

The team noted that the sampling place was well chosen at the outside curve of the Elbe River. Another sampling station is located directly at the German border (at Hřensko). At that place, collaboration with Germany for common sampling is in place.

Sediment sampling is performed at another location at Děčín. Measurements are performed by another laboratory of *Povodí Labe*. The team was shown the sediment sampler used for such tasks.

The team was also shown the sampling plan for the week with the current tasks marked.

The sample sheet contained the following data: date, time of sampling, as well as information on pH, oxygen, temperature, filled in by hand at location, signature. The technician demonstrated the on-site measurements with the equipment available in the car.

A manual with a description of all sampling procedures was available in the car. The car was equipped with an air conditioning system to keep samples at low temperature.

The verification does not give rise to remarks.

8.2 DOSE RATE MONITORING STATION (HYDROMETEOROLOGICAL INSTITUTE, BRANCH OFFICE USTÍ NAD LABEM)

The verification team visited and verified the ambient dose rate monitors of the national network (telemetric Early Warning Network) installed at the Branch Office of the Czech Hydrometeorological Institute in Ustí nad Labem. The location of the "meteorological garden" is very good, on a hill. The local situation with lawn, low bushes, a small tree at some 30 m distance and a two-storey building some 20 m is also good.

The ambient gamma dose rate monitor consists of two detector tubes (*Berthold Micro-Gamma LB111* with data logger), one for low dose rate (proportional counter *Berthold LB6360*) and one for high dose rate (Geiger Müller counter *Berthold LB6500-3*). The measuring range is from $5 \cdot 10^{-8}$ to 10 Sv/h. At the time of the visit the values were 0.117 µSv/h and 0.392 µSv/h, which was quite irritating to the team, since there was no information on accuracy of the values or to which detector probe which value belonged. The detector tubes are mounted ca. 1 m above ground and ca. 1 m apart from each other on a common frame. They are slightly shielded by non-radiological devices.

Envinet, Czech company, provides the service for the system. Every month a technician checks the device with a Cs-137 source from *'Inspektorát pro ionizujíci záření'* (the checking position is marked on the 'low' dose rate device); a special tool with a strap allows fixing the source at the probe. The source is stored at site and was shown to the team.

The corresponding data communication system is PC based and displays meteorological data as well as dose rate values (incl. integral). These data are transmitted to the central Hydrometeorological Institute in Prague and to SÚRO (10-minute values, times in UTC).

A the time of the verification, a TLD was mounted 1 m above ground, in a plastic bottle. It is changed every three months.

> *The verification team recommends re-arranging the ambient gamma dose rate detector tubes in order to avoid any shielding effects. It also suggests finding a solution to avoid presentation of very deviating values for the two detectors. This could be done e.g. by either showing '---' for the less reliable value or by giving uncertainties or a similar method.*

8.3 SÚJB Regional Centre Ustí nad Labem

The verification team visited the SÚJB regional office (Regional Centre, RC) in Ustí nad Labem situated at ca. 3 km distance from the Branch Office of the Czech Hydrometeorological Institute in the same town.

The centre operates an ambient dose rate monitor *Berthold Micro Gamma LB111* (same type as the device at the Hydrometeorological Institute) mounted in the garden 1 m above ground, and situated ideally without any shielding obstacles. The general location of the measurement and sampling devices in the garden is very good, outside of the town, on a soft hill.

The team witnessed also a precipitation sampler consisting of a red plastic basin of ca. 50 cm diameter. Precipitation samples are taken once per month and analysed in the SÚJB laboratory at Hradec Králová.

The centre has also a high volume aerosol sampler of the type *Senya JL-150 Hunter* operating. Its calibration is performed by the company *Envinet* (based on a contract by the State Office for Nuclear Safety - SÚJB Prague). Filters are changed once per week and measured by the regional SÚJB centre at Hradec Králové (always on Tuesdays).

Envitec provides services for all equipment and performs also the dose rate monitor tests with a Cs-137 source (source from *'Inspektorát pro ionizujíci záření'* type *EG3*, stored at the regional centre).

A portable gamma detector of the type *Exploranium 135* device with NaI(Tl) detector, was available for low resolution gamma spectroscopy in the field (in a similar way as at SÚJCHBO).

A PC serves for data transmission. Every 10 minutes the data of the status of the dose rate detector and of the *Exploranium 135* device are sent to SÚRO within the network (normal) or by GSM (backup). These messages are automatically generated. Staff checks daily if everything is ok (this is the only task related to the equipment). In case of a problem, the colour on the PC-display changes to red.

At the time of the verification the dose rate monitor indicated 0.100 µSv/h (low dose rate) and 0.281 µSv/h (high dose rate).

Two UPS devices (*1208*, *2424*) of *Envinet A.S.* assure electric power supply.

The regional centre also takes foodstuff samples etc. according to the environmental monitoring programme. These samples are registered (number), dried and then sent to the Hradec Králové laboratory for analysis (e.g. wheat flour 465 g in 0.5 l Marinelli beaker). Such samples are taken every three months.

The verification suggests finding a solution to avoid presentation of very deviating values for the two gamma dose rate detectors.

8.4 SÚJB REGIONAL CENTRE BRNO

The verification team visited the regional office of the State Office for Nuclear Safety (*Statní úřad pro jadernou bezpečnost*, SÚJB) in Brno which deals mainly with the early warning network, the TLD network and large volume aerosol samplers. Three radioactivity measurement devices are available:

- a *Tri carb 2560XL* liquid scintillation counter (LSC) for high activity samples;
- a *Tri carb 3170 TR SL* LSC for low activity samples;
- an *EMS3 alfa beta automat* device.

A log book is kept for sample registration and in addition to a consecutive number, details of the date sample received, the locality where the sample was taken, the kind of sample and the analyses to be performed are recorded.

Results are recorded locally and uploaded into the database of the National Radiation Protection Institute where they are available to the public.

Calibration of the devices is every two years by the Czech national metrological institute.

Two mobile teams equipped with *Exploranium Minispec GR-130* detectors are on standby for emergency situations.

A visit was made to a monitoring site situated in the botanic gardens attached to the university. The instruments - belonging to the national monitoring network, in particular the gamma counters to the telemetric early warning network - are in a secure environment, thanks to the surrounding fence. Equipment consists of:

- a *JL-150 Hunter* air sampler, filters are changed weekly;
- a TLD housed in a plastic bottle;
- 2 gamma counters (one low dose rate proportional, and a GM counter for high dose rate).

Originally the gamma counters were situated 1 m above ground level, however works carried out in the garden led to soil being piled up in a mound around the device resulting in the detector now only being +/- 50 cm above ground level. As the site does not belong to SÚJB they have little influence over the management and it is felt that the security of the site is more important.

The verification team suggests exploring the possibility to site the detectors at one metre above ground, with a view to allow the usage of the data also for deposition estimates.

8.5 SÚJB REGIONAL CENTRE PŘIBRAM-MILÍN-KAMENNÁ

During the verification at SÚJCHBO, the team had the possibility to briefly visit the regional office of the State Office for Nuclear Safety (SÚJB) in Příbram-Milín-Kamenná, which is located at the same premises. A close collaboration exists between the two institutions.

The office was not part of the verification. However, the team noted the presence of a gamma dose rate monitor *Berthold LB111* (belonging to the telemetric early warning system), of a 1 m^2 precipitation sampler, and of a high volume aerosol sampler *Senya JL-150 Hunter* in the yard.

8.6 SÚRO PRAGUE

The verification team visited the laboratory of the National Radiation Protection Institute (*Státní ústav radiační ochrany*, SÚRO) in Prague. The laboratory was verified already during the 2005 Article 35 EURATOM verification visit.

The laboratory has ISO 17025 accreditation valid from 1/7/2009 until 10/6/2014 for all measurements undertaken in the course of the national monitoring programme. A number of other measurements, also covered by the accreditation are undertaken, e.g. building materials.. A full methodology and set of procedures was available for inspection.

The national TLD network covers +/- 200 points on the national territory. Film is placed at 1m height both outside buildings, and also inside buildings in some cases with a view to measuring the shielding effect. Ambient dose equivalent is thus measured quarterly. From 2010 onwards the laboratory uses a *Harshaw 4000* reader. Additionally a *Rados DBR 2* is available for portable measurements should the need arise.

The low activity alpha/beta laboratory is equipped with 12 *Canberra* alpha spectrometers, 3 automatic liquid scintillation counters. In addition a *Frisch* grid chamber for alpha measurements is available.

The radiochemical laboratories serve for sample preparation for both gamma spectrometry and alpha/beta analysis. Analyses carried out are for H-3, C-14, Sr, actinides and natural radionuclides (U, Ra, Th etc).

The gamma laboratory is comprehensively equipped with a total of 14 HPGe detectors covering a wide range of geometries. A low background is achieved through lead or steel shielding. Standards for calibration are supplied by the Czech Metrology Institute every 2 years.

Canberra Genie 2000 is used for data acquisition, display and analysis of gamma and alpha spectrometry data. The data is input to the book of measurements and then uploaded to the book of analyses. All data from sample taking to results was presented in a very clear manner. A single sample may have more than one result, e.g. alpha and gamma measurements.

SÚRO Prague performs all radon measurements within the national radon survey that covers some 150 000 houses and all schools and kindergartens in the Czech Republic.

The verification does not give rise to remarks.

8.6.1 Emergency preparedness

At present a *Landrover* 4x4 is used for the transport of material for mobile measurements. The verification team was informed that this is only a replacement for the principal vehicle which is undergoing repair and a rebuild. An army helicopter is available on 6 hours notice. Should it be necessary SÚRO may also call upon the police who may be able to offer air support in a shorter time.

The mobile group comprises four teams of two people who are available 24/7. During working time the response time in the case of an alert is 30 minutes, whilst outside this time the team should respond within two hours.

The Mobile group is equipped with: portable gamma spectroscopy equipment (HPGe and scintillation counter), air samplers, dose rate meters (with GPS) and alpha measurement instruments. For airborne gamma spectrometry both the IRIS (integrated radiation information system) system consisting of a 4x4 dm^3 NaI(Tl) spectrometer and a HPGe spectrometer are used.

9 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 and 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 of the national radiological monitoring network. They do not discredit the fact that the monitoring as far as included in the verification is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(3) The verification findings and ensuing recommendations are compiled in the 'Main Findings' document that is addressed together with the present technical report to the Czech competent authorities through the Czech Permanent Representative to the European Union.

(4) The Commission services ask the Czech competent authority to inform them of any progress or significant changes with regard to the situation at the time of the verification.

(5) 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

Monday 18/10	Opening meeting with Czech authorities, presentations of mining and milling issues, legal aspects	
	Travel from Prague to Liberec	Travel from Prague to Brno
Tuesday 19/10	Site specific explanations (north CZ) Verification of the local operator's lab Verification of (former and recent) mining/milling sites and tailings ponds; Stráž pod Ralskem (in particular groundwater issue)	Site specific explanations (central/east CZ) Verification of the local operator's lab Verification of (former and recent) mining/milling sites and tailings ponds; Rozna, Dolní Rožínká
Wednesday 20/10	Verification of (former and recent) mining/milling sites and tailings ponds; Stráž pod Ralskem (continuation) Verification of the national monitoring system in the region of Liberec	Verification of (former and recent) mining/milling sites and tailings ponds; Rozna, Dolní Rožínká (continuation) Verification of the national monitoring system in the region of Brno
Thursday 21/10	Travel from Liberec to Příbram-Kamenná Verification of the laboratory at the National Institute of Nuclear, Chemical and Biological Protection Travel from Kamenná to Prague	Travel from Brno to Prague Verification of the laboratory at the National Radiation Protection Institute (SÚRO)
Friday 22/10	Closing Meeting	

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 Czech authorities in preparation of the visit, an explanatory text document with numerous detailed appendixes was received. The document answers relevant questions concerning uranium mining and milling in the Czech Republic (legal situation; competent authorities; uranium mining and milling - historical and actual situation; radiological site monitoring and remediation activities, etc.) and gives an overview over the national radiological monitoring network.

Consulted web sites

Environmental protection legislation: http://www.mzp.cz/ris/vis-legcz-en.nsf/

State office for Nuclear Safety, SÚJB: http://www.sujb.cz/?r_id=26

National Radiation Protection Institute, SÚRO: http://www.suro.cz/en

National Nuclear, Chemical and Biological Protection Institute, SÚJCHBO:
http://www.sujchbo.cz/index.php?lang=en

DIAMO state enterprise: http://www.diamo.cz/en/

Radiation monitoring network:
http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/36/097/36097698.pdf