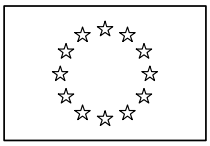

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

Germany

27th to 31st August 2007

Reference: DE-07/05

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Installations of Wismut GmbH in the Land of Saxony in the Federal Republic of Germany.
SITES:	
DATE:	27th through 31st August 2007
REFERENCE:	DE-07/05
INSPECTORS:	Mr F. MacLean (Head of team) Mrs Å. Wiklund Mr P. Vallet
DATE OF REPORT:	18/11/2008

SIGNATURES:

[signed]

F. MacLean

[signed]

Å. Wiklund

[signed]

P. Vallet

TABLE OF CONTENTS

TECHNICAL REPORT

1. ABBREVIATIONS

AtStrZuVO	Saxon Ordinance on Responsibilities for Nuclear and Radiation Protection *(Verordnung des Sächsischen Staatsministeriums für Umwelt und Landwirtschaft über die Zuständigkeiten zum Vollzug atom- und strahlenschutzrechtlicher Vorschriften (Zuständigkeitsverordnung Atom- und Strahlenschutzrecht))*
AVV-IMIS	General Administrative Provision on the Integrated Measuring and Information System for Monitoring Environmental Radiation *(Allgemeine Verwaltungsvorschrift zum Integrierten Mess- und Informationssystem zur Überwachung der Radioaktivität in der Umwelt (IMIS) nach dem Strahlenschutzvorsorgegesetz)*
BfS	Federal Office for Radiation Protection *(Bundesamt für Strahlenschutz)*
BMU	Federal Ministry for the Environment, Nature Conservation and Reactor Safety *(Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)*
DAR	German Accreditation Council *(Deutscher Akkreditierungsrat)*
DDR / GDR	German Democratic Republic *(Deutsche Demokratische Republik)* – former East Germany
DG TREN	Directorate General Energy and Transport
DKD	German Calibration Services *(Deutscher Kalibrierdienst)*
EC	European Commission
GM	Geiger Müller (radiation detector)
GRS	*Gesellschaft für Anlagen- und Reaktorsicherheit mbH* (The Installation and Reactor Safety Limited Company).
HaldAO	Ordinance on Radiation Protection at Heaps and Industrial Repositories *(Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei der Verwendung darin abgelagerter Materialien vom 17. November 1980)*
HPGe	High Purity Germanium (high resolution gamma detector)
IAEA	International Atomic Energy Agency
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectrometry
ICRP	International Commission on Radiological Protection
IMIS	Integrated Measuring and Information System (for Monitoring Environmental Radiation)
ISO-17025	International Organization for Standardization, Standard 17025, General Requirements for the Competence of Testing and Calibration Laboratories
JRC	(European Commission) Joint Research Centre
LIMS	Laboratory Information Management System
LfUG	Saxon State Agency for Environment and Geology *(Landesamt für Umwelt und Geologie)*
LLA	Long Lived Alpha
MCA	Multi-Channel Analyzer (electronic device for measurements)
NaI(Tl)	Sodium Iodide Thallium activated (low resolution gamma detector crystal)
NORM	Naturally Occurring Radioactive Material

ppm	Parts per million (equivalent to milligrammes per litre)
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
QA	Quality Assurance
QC	Quality Control
RAID	Redundant Arrays of Inexpensive Disks (the use of two or more redundant hard-disks to increase the security of computer data)
REI Bergbau	Directive on Emission and Immission Monitoring regarding Mining *(Richtlinie zur Emissions- und Immissionsüberwachung bei bergbaulichen Tätigkeiten)*
REM	Radioactivity Environmental Monitoring (European database at JRC Ispra)
SächsVwOrg(G)	Law on the Administrative Organisation of Saxony *(Gesetz über die Verwaltungsorganisation des Freistaates Sachsen)*
SAG Wismut	Soviet Stockholding Company Wismut
SDAG Wismut	Soviet-German Stockholding Company Wismut
SMUL	Saxon State Ministry for Environment and Agriculture
StrlSchV	Radiation Protection Ordinance *(Verordnung über den Schutz vor Schäden durch ionisierende Strahlen – Strahlenschutzverordnung)*
StrVG	Act on the Precautionary Protection of the Population against Radiation Exposure *(Strahlenschutzvorsorgegesetz)*
TLD	ThermoLuminescence Dosimetry
UBG	State Environment Management Company *(Staatliche Umweltbetriebsgesellschaft)*
UPS	Uninterruptible Power Supply
VKTA	*Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V.*
VOAS	Ordinance on Atomic Safety and Radiation Protection with Executive Instructions (Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz und Durchführungsbestimmung zu dieser Verordnung)
VwV UBG	Administrative Regulation of the SMUL concerning the State Environmental Management Company (UBG) *(Verwaltungsvorschrift des Sächsischen Staatsministeriums für Umwelt und Landwirtschaft über den Staatsbetrieb "Staatliche Umweltbetriebsgesellschaft")*

2. INTRODUCTION

2.1 Euratom Article 35

Article 35 of the Euratom Treaty requires that each Member State shall establish facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic standards[1].

Article 35 also gives the European Commission the right of access to such facilities in order that it may review and verify their operation and efficiency.

Within the Commission, the Radiation Protection Unit (TREN.H4) of Directorate-General Energy & Transport (DG TREN) is responsible for conducting these verifications.

The main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of facilities (insofar as applicable in the Member State) for monitoring:

- liquid and airborne discharges of radioactivity into the environment by sites (and control thereof).
- levels of environmental radioactivity at site perimeters and in the marine, terrestrial and aquatic environment around sites, for all relevant pathways.
- levels of environmental radioactivity on the territory of Member States.

The Commission has published a Communication[2] in 2006 being the subject of Article 35 verifications, including the practical arrangements made for the verifications. This verification was executed in conformity with the Communication.

For the purpose of this particular verification, a single verification team from DG TREN visited sites in the State of Saxony where formerly activities related to uranium mining were carried out and which currently are being rehabilitated by the Wismut company. The visit did not include verification of the federal (national) system for monitoring environmental radioactivity. The visit included meetings with representatives of the responsible federal and state environment ministries (BMU and SMUL respectively) as well as organisations involved in authorisation or oversight of the rehabilitation operations. The verification included visits to the laboratories of both the operator and the control authorities.

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance of radioactivity related to the remediation operations of Wismut GmbH in the state of Saxony, Germany.

The report is also based on information collected from documents received and from discussions with various persons met during the visit.

The verification team wishes to express its gratitude to all participants for their co-operation in the accomplishment of the team's aims.

2.2 Note on Terminology

For the sake of conciseness the word *immission* is employed throughout this report to mean the effects of radioactivity released upon the environment.

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

2, Verification of Environmental Radioactivity Monitoring Facilities under the terms of Article 35 of the Euratom Treaty. Practical Arrangements for the Conduct of Verification Visits in Member States. Official Journal of the European Union, 2006/C 155/02, 4/7/2006

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1 Preamble

The Commission notified Germany of its intention to carry out a verification mission under the terms of Article 35 of the Euratom Treaty by means of a letter reference TREN/H4/CG/cd D (2007) 307055 sent 16 April 2007 to the Permanent Representative of Germany to the European Union. The Federal Ministry for the Environment, Nature Conservation and Reactor Safety (BMU) acted as the Commission's contact partner for the organisation of the visit.

3.2 Scope of the Verification

Wismut GmbH carries out remediation in the state of Saxony and in the state of Thuringia. Given that only a single verification team was available to execute the verification, it was decided to limit the verification to the remediation of Wismut GmbH locations in Saxony. For the same reasons, the Federal (national) monitoring system for environmental radioactivity was not included in the scope of the verification.

Wismut GmbH was established to remediate locations owned by the SDAG Wismut at the time of re-unification. However, a number of locations associated with uranium mining or ore processing had been transferred out of the ownership of SDAG Wismut in the late 1950's and early 1960's. These sites, known as "legacy sites", are not contained within the scope of the Wismut remediation project and their remediation is in accordance with separate arrangements between local, state and federal authorities. During the Middle Ages other, non-radioactive, ores such as silver and copper had also been mined in this region, bequeathing their own environmental problems. These sites are also considered as "legacy sites". The rehabilitation of both types of legacy sites was not included in the scope of the verification visit.

The Wismut project includes remediation related to non-radioactive chemical pollutants. This aspect of the Wismut project is also outside the scope of this verification.

3.3 Programme of the visit

The programme of verification activities and the list of monitoring points to visit were discussed and agreed upon during the preparatory phase, and with minor modifications were finalised during the opening meeting. The programme, as executed, is attached as Appendix 1. In addition, the final list of the locations visited during the visits to the remediation sites is attached as Appendix 2.

Verification activities at the sites and laboratories addressed technical aspects of monitoring and sampling, analytical methods, quality control and quality assurance, archiving, and reporting of data.

The opening meeting was held in the premises of the Saxon Environment Ministry in Dresden on the 27th of August. At the end of the visit the verification team presented its preliminary conclusions, subject to further verification of received information back at headquarters.

3.4 Documentation

In order to facilitate the work of the verification team, the operator and the federal and state authorities concerned prepared an information package in response to a questionnaire submitted by the Commission Services. Regular telephone conferences were also held in order to respond to requests for clarification and to plan the visit. Appendix 3 summarises the documentary information provided. The verification team noted the quality and comprehensiveness of all the presentations and documentation, which have been extensively drawn upon in the descriptive sections of this report.

3.5 Representatives of the competent authorities and the associated laboratories

Opening Meeting
Bühling, Müller-Neumann : BMU
Leder, Simpfendörfer, Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
P. Schmidt, Wolf : Wismut GmbH
Gehrcke : BfS

UBG Dresden
Bühling, Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
P. Schmidt : Wismut GmbH
Gehrcke : BfS
Heinrich, Abraham, Lange, Engert : UBG

Wismut Königstein Site
Bühling, Müller-Neumann : BMU
Sperrhacke : SMUL
Richter, Arthen : LfUG
Heinrich : UBG
Kurz, Kretzschmar, P. Schmidt, Kreyßig, Friedrich : Wismut GmbH
Gehrcke : BfS

UBG Chemnitz
Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
Heinrich, Preuße, Günther, Fichtner, Sonntag : UBG
Gehrcke : BfS

Wismut HQ
U. Schmidt : Sächsisches Oberbergamt, Gera
Baltes : Thüringer Umweltministerium
Reinhardt, Frommhold, Kreyßig, Quellmalz, P. Schmidt : Wismut GmbH
Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
Gehrcke : BfS

Wismut Central Laboratory Seelingstädt
U. Schmidt : Sächsisches Oberbergamt, Gera
Baltes : Thüringer Umweltministerium
Frommhold, Kreyßig, Wolf, Schumann, Fleischer, Grunewald, Nürnberger : Wismut GmbH
Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
Gehrcke : BfS

Wismut Air Monitoring and Gamma Calibration Laboratories, Ronneburg
U. Schmidt : Sächsisches Oberbergamt, Gera
Baltes : Thüringer Umweltministerium
Knittel, Kreyßig, Wolf : Wismut GmbH

Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
Gehrcke : BfS

Wismut Crossen Site
Kreyßig, Rach, Stracke, Wolf : Wismut GmbH
Bühling, Müller-Neumann : BMU
Sperrhacke : SMUL
Richter, Ritzel : LfUG
Heinrich : UBG
Gehrcke : BfS

Wismut Schlema/Aue Site
S. Schmidt, P Schmidt, Kreyßig, Rach, Speer : Wismut GmbH
Bühling, Müller-Neumann : BMU
Sperrhacke : SMUL
Richter, Ruhl : LfUG
Heinrich : UBG

Felsenkeller - Underground Laboratory
Köhler, Schäfer : VKTA Rossendorf
Bühling, Müller-Neumann : BMU
Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
P. Schmidt : Wismut GmbH

Final Meeting
Bühling, Müller-Neumann : BMU
Leder, Simpfendörfer, Sperrhacke : SMUL
Richter : LfUG
Heinrich : UBG
P. Schmidt, Wolf : Wismut GmbH

4. URANIUM MINING IN SAXONY AND THURINGIA

4.1 History

Mining has a long tradition in the states of Saxony and Thuringen. Already in the 12th century silver was being mined in the region. Some centuries later coal was being mined and closer to our time nickel and cobalt deposits were exploited. In 1947 the Soviet Union established SAG Wismut to exploit uranium resources in Saxony and Thuringia in order to provide the uranium needed for the Soviet Union's nuclear programme. During the existence of SAG Wismut little attention was paid to working conditions, public health or the environmental impact of operations. In 1954 the German Democratic Republic became co-owner and the company was re-named SDAG Wismut. With the change in ownership greater attention was paid to these issues.

At its peak the company employed 120 000 workers and was by termination of uranium production in 1990 the third largest producer of uranium in the world. Although the uranium content of the ore was low production continued, driven by the demand for uranium for the Soviet nuclear programme. Mining was carried out in open pits and in underground mines. Initially, ore was processed in small processing plants near the mines, but by the 1950's ore processing was largely concentrated at two large uranium mills located at Crossen (Saxony) and Seelingstädt (Thuringia) respectively.

4.2 Remediation of Wismut sites

However, production costs at Wismut were significantly higher than the market price of uranium and so German re-unification brought with it the end of uranium production. The former mining sites now represented a major environmental liability and in 1991 the government of the Federal Republic of Germany initiated a €6,6 billion, 20-year programme to rehabilitate the sites and locations related to uranium mining and uranium ore processing which were still operated by the SDAG Wismut company at the time of re-unification. A state-owned company, Wismut GmbH, was founded in December 1991 to perform this task said to be the largest environmental remediation project in Europe.

The WISMUT remediation project is one of the most complex environmental rehabilitation projects in the world. The rehabilitation project covers a large geographical area, many locations, and involves dealing with enormous volumes of spoil and other residues[3]. Many operational areas were close to population centres and some of the former workings are even close to large population centres such as Dresden.

Wismut operations before 1990 were subject to the highest degree of secrecy and the Soviet owned company formed "a state within the state" possessing its own power-generation, health service and police. Monitoring of radiation levels was performed by the company.

The Wismut project, summarised in table 1, covers the rehabilitation of the sites that were under the responsibility of SDAG Wismut when uranium production ceased.

Table 1. The extent of the Wismut remediation project (1991)

Operational areas	3700 ha
Mine shafts	56
Underground drifts	1400 km
Spoil heaps	48 with a total volume of over 300 million cubic metres.
Tailing ponds	6 ponds, with a total surface area of 570 ha and a total volume of 180 million cubic metres.
Open cast pits	1 pit, 160 ha surface area and an open volume of 84 million cubic metres.
Processing plants	2 plants on sites covering a total of 140 ha.

4.3 Remediation of legacy sites

As noted previously, a number of locations formerly associated with uranium mining or ore processing were transferred out of the ownership of SDAG Wismut in the late 1950's and early 1960's. These sites, known as 'legacy sites', are not contained within the scope of the Wismut remediation project

Between 1991 and 2000 BfS (Bundesamt für Strahlenschutz) and GRS (Gesellschaft für Anlagen- und Reaktorsicherheit mbH) made an inventory of the legacy locations and legacy objects in the states Saxony, Thuringia, and Saxony-Anhalt in order to identify those where remediation is needed or where limitations on access and use need to be applied. In Saxony, 25 such areas and 5314 locations such as spoil heaps, contaminated buildings etc, were identified (summarised in table 2). About 600 of them have been classified as possible radiologically relevant sites.

[3] To produce 1 tonne of uranium approximately 1100 tonnes of uranium ore was required. In order to obtain 1 tonne of uranium ore, about 2 tonnes of mineralized rock had to be mined. This resulted in huge amounts of mining and production residues.

Table 2. Extent of legacy sites

Type	Approximate number
Spoil heaps	Several thousand
Ore loading stations	Several dozen
Tailings ponds	Around 100
Shafts, galleries	More than 1000
Operational areas	More than 100

These areas and objects are mostly privately owned or are owned by municipalities or other public bodies, making it legally difficult to obtain the necessary access for rehabilitation. In 2003 the Federal Government and the Government of Saxony signed an administrative agreement concerning the financing of remediation activities at the legacy sites. The execution of this project, with a total budget of €78m, is co-ordinated by an advisory council for the restauration of abandoned uranium mining and milling sites, which is using the Wismut GmbH as its project executing organization.

5. LEGISLATION AND COMPETENT AUTHORITIES

5.1 Introduction

In Germany, the reponsibility for monitoring radioactivity in the environment as defined by Article 35 of the Euratom Treaty is shared by the Federal and State (Land) levels. The Act on the Precautionary Protection of the Population against Radiation Exposure (Strahlenschutzvorsorgegesetz, StrVG) sets out the respective responsibilities and tasks of the Federal and State levels as well as the responsible executive agencies at the Federal level. It is complemented by the General Administrative Provision on the Integrated Measuring and Information System for Monitoring Environmental Radiation (AVV-IMIS), which describes the modalities for collecting measurements of environmental radioactivity in the national system. The programmes, however, are not geared towards monitoring specific emitters or natural radionuclides. Nor are they geared towards site specific monitoring.

(A full list of relevant national and state legislation can be found in Appendix 4).

5.2 National legislation covering uranium mining and remediation

Prior to reunification there was no legal framework in western Germany to cover the uranium mining industry, and therefore the re-unification treaty provided for the continuing applicability of DDR law governing atomic safety and radiation protection in the uranium mining industry, including provisions relating to environmental monitoring; specifically the Ordinance on Atomic Safety and Radiation Protection (VOAS), and the Ordinance on Radiation Protection at Heaps and Industrial Repositories (HaldAO).

To complement this legislation, in 1997 the Federal Government adopted the Directive on Emission and Immission Monitoring regarding Mining (REI Bergbau) in order to complement the provisions of the VOAS and its Executive Instructions. The REI Bergbau only applies to mining activities, including decommissioning and remediation, in the new Federal States of Germany. The measures in the REI-Bergbau are aligned with practices applied in relation to nuclear installations. (Note: emission monitoring means the monitoring of discharges of radioactive substances whereas immission monitoring serves to observe the effects of the discharge of radioactive substances into the environment).

When the Federal Radiation Protection Ordinance (StrlSchV) was updated in 2001, new provisions were added (Articles 48 and 118) relating to monitoring of decommissioning and remediation of sites and locations associated with uranium mining.

Nonetheless, the bulk of the requirements relating to environmental monitoring are to be found in the detailed prescriptions of the REI-Bergbau, including the execution of the operator's monitoring programmme; independent control of the operator's monitoring programme; assessment of

meteorological effects; sample taking methods and frequencies; detection thresholds; reporting of the results of the operator's own programme and of the control programme. The REI-Bergbau is thus the principal piece of legislation in respect of monitoring of environmental radioactivity related to the Wismut remediation project.

5.3 Saxon legislation covering uranium mining and remediation

The fields of competence of the ministries in Saxony are set out in a decree of the Saxon State Government, and in the Saxon Law on the Administrative Organisation of Saxony (SächsVwOrg(G)). Insofar as uranium mining, and nuclear and radiological matters are concerned, the Saxon Environment and Agriculture Ministry (SMUL) carries the primary responsibility.

A SMUL Ordinance (AtStrZuVO) sets out responsibilities within Saxony for the execution of tasks and responsibilities arising from the Federal Atomic Law (AtG) and the Federal Radiation Protection Ordinance (StrlSchVO). The AtStrZuVO also assigns responsibilities to meet requirements arising out of the two pieces of former DDR legislation which continued to be applicable in the new Federal States after re-unification: viz. the Ordinance on Radiation Protection at Heaps and Industrial RepositoriesTailings Ponds (HaldAO), and the Ordinance with Executive Instructions on Atomic Safety and Radiation Protection (VOAS).

The AtStrZuVO makes the Saxon State Agency for the Environment and Geology (LfUG) responsible for granting permits to undertake activities related to remediation. It also makes LfUG responsible for the surveillance and control of remediation, including for the independent evaluation of the operator's own monitoring program.

The LfUG is assisted in its tasks by the State Environmental Management Company (UBG). LfUG and UBG's respective responsibilities and tasks are described in the Administrative Regulation of the SMUL concerning the State Environmental Management Company "UBG" (VwV UBG).

LfUG and UBG are technical services responsible to SMUL, which carries the political responsibility for monitoring of environmental radioactivity. In part at least, this structure represents a continuation of the control arrangements existing before German re-unification.

5.4 Related Legislative Provisions

5.4.1 Authorisation for return of land to public use

According to § 4 of the HaldAO, the reuse of mining heaps and sedimentation facilities requires authorisation. This is still true in cases where radioactive substances could not be completely removed in the clean-up. The responsibilities for radiation protection in case of a modification in the legal control, ownership or right of use of areas in which mining heaps and sedimentation facilities are located, are laid down in § 2 of HaldAO.

Remediation licenses set out the objectives with respect to clean-up and subsequent re-use. Remediation objectives reflect the future use which is envisaged. The licensing procedure requires Wismut GmbH to demonstrate that a certain annual effective dose to members of the public will not be exceeded. Respect of licencing objectives is verified by control measurements made by UBG or other sub-contractors commissioned by the authorities.

Changes in the planned use of remediated objects are subject to a new authorisation.

It should be noted in passing that, as relevant, Wismut GmbH sites are also subject to the general mining legislation. However, this lies outside the scope of this verification.

If residues or materials are removed from uranium mining facilities, section 3 chapter 3 of the Ordinance on Radiation Protection is applicable (StrlSchV). LfUG is responsible for the implementation of the Ordinance and for supervision in accordance with § 6 AtStrZuVO.

5.4.2 Inspection of licensed facilities.

In accordance with § 15 number 2 of AtStrZuVO, LfUG is responsible for supervision of Wismut GmbH's remediation activities.

In support of LfUG, UBG performs measurements and processes data on environmental radioactivity in accordance with Number II of the VwV UBG. UBG may also be commissioned by SMUL or LfUG to measure the influence of environmental radioactivity on selected installations or media.

Emergency preparedness.

The state of the remediation programme and the nature of operations currently performed by Wismut GmbH are such that a significant nuclear emergency is highly unlikely and hence there are no specific measures in place for Wismut regarding major radiological emergencies. (The Helmsdorf tailings pond had previously been included in Saxony's emergency response programme due to the potential risk from failure of the dam in the time before drainage of the pond).

Nonetheless, SMUL require LfUG and UBG to maintain a 365 day per year call-out service to provide technical support to other authorities such as the Fire Service should an incident occur involving radioactive materials.

5.5 Competent Authorities for monitoring of Environmental Radioactivity related to Wismut GmbH

⇨ *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
Robert-Schuman-Platz 3
53175 Bonn

⇨ *Sächsisches Staatsministerium für Umwelt und Landwirtschaft* (Saxon State Ministry for the Environment and Agriculture)
Archivstraße 1
01097 Dresden

⇨ *Landesamt für Umwelt und Geologie* (Saxon State Agency for the Environment and Geology)
Zur Wetterwarte 11
01109 Dresden

⇨ *Staatliche Umweltbetriebsgesellschaft Sachsen* (UBG)
Dresdner Straße 78C
01445 Radebeul

5.6 Other organisations participating in monitoring of environmental radioactivity in respect of Wismut

No other authorities participate in monitoring environmental radioactivity in relation to Wismut operations although LfUG has occasionally commissioned external experts, in accordance with §20 of AtG when specialised activities were performed.

5.7 Guidance and other non-legally binding documents

There are numerous European and other international documents, such as technical instructions, directives and recommendations with respect to radiation protection and environmental monitoring that are taken into consideration in the process of evaluating and optimising the remediation measures in the framework of the Wismut project. The most important are listed below:

/EC-90/ Commission Recommendation of 21 February 1990 on the protection of the public against indoor exposure to radon (90/143/Euratom), Brussels, 1990.

/EPA-83/ Standards for the Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites, U.S. Environmental Protection Agency, 1983.

/EPA-89/ Health and Environmental Protection Standards for the Uranium and Thorium Mill Tailings, U.S. Environmental Protection Agency, 1989.

/IAEA-92/ Current Practices for the Management and Confinement of Uranium Mill Tailings, IAEA Technical Report Series No. 335, Vienna 1992.

/IAEA-94/ Decommissioning of Facilities of Mining and Milling of Radioactive Ores and Close Out of Residues, IAEA Technical Report Series No. 362, Vienna, 1994.

/IAEA-96/ Int. Basic Safety Standards for Protection Against Ionising Radiation and for the Safety of Radiation Sources, Safety Series No. 115, 1996.

/IAEA-02/ Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium, Safety Report Series No. 27, Vienna, 2002

/IAEA-05/ Safety Standards, Safety Guide No. RS-G-1.8: Environmental and Source Monitoring for Purposes of Rad. Protection, 2005.

/ICRP-84/ ICRP Publication 43: Principles of Monitoring for the Radiation Protection of the Population, 1984.

/ICRP-86/ ICRP Publication 47: Radiation Protection of Workers in Mines, 1986.

/ICRP-90/ ICRP Publication 60: 1990 Recommendations of the International Commission on Radiological Protection, 1990.

/ICRP-93/ ICRP Publication 65: Protection Against Radon-222 at Home and at Work,1993.

/ICRP-84/, /IAEA-02/ and /IAEA-05/ directly refer to environmental monitoring of areas where decommissioned uranium mining sites are being rehabilitated. The documents /EC-90/, /IAEA-96/, /ICRP-90/ and /ICRP-93/ recommend targets for compliance in the environment and workplaces.

6. THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

6.1 Introduction

The radiological situation on the territory of Germany is monitored by systematic measurement of ambient gamma dose rate at locations throughout Germany and by measurements of the radionuclide content in environmental media, food and feedstuffs. As described above, responsibilities for providing the relevant data are distributed between the Federation and the States. The system is designed to acquire data for evaluation of the radiological situation under both normal and emergency conditions.

6.2 National Monitoring Programme

The German national programme for monitoring of environmental radioactivity originated in the 1950's partly as a response to the spread of radioactive fall-out from atmospheric tests of nuclear weapons and partly to respond to the need to meet the obligations on Germany arising from its membership of the European Atomic Energy Community (Euratom).

Following the Chernobyl accident, the monitoring programmes of the various Federal and State (*Länder)* ministries were fully integrated with the creation of IMIS (Integrated Measuring and Information System for the Surveillance of Environmental Radioactivity) which covers all of Germany and comprises more than 2000 fixed monitoring stations, as well as more than forty specialised Federal and *Länder* laboratories analysing more than 10 000 samples per year. In addition each state is

obliged to provide at least one mobile measurement station, BfS fields its own mobile measurement stations, and has access to a helicopter if needs be.

IMIS is managed by the Federal Office for Radiation Protection (BfS) on behalf of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU). Environmental monitoring is carried out according to the AVV-IMIS (latest revision December 2006), which sets out a comprehensive (212 pages) sampling and measurement programme for the various Federal and *Länder* agencies concerned.

IMIS covers nationally and locally organised monitoring. Federal networks are responsible for monitoring ambient gamma dose rate, air, precipitation, federal waterways, the North Sea and the Baltic Sea whereas States are responsible for monitoring of soil, food, plants, drinking water, surface and ground water, waste, sewage, fertilizers and pharmacons. However, IMIS does not directly cover immission and discharge monitoring in respect of specific sites, e.g. nuclear facilities or Wismut sites.

BfS is responsible for the following aspects of the national programme: the operation of the Federal network of fixed gamma doserate measuring equipment installed at 2150 locations (97 of which are on the territory of Saxony); environmental radioactivity resulting from mining activities; naturally occurring radioactivity e.g. radon surveillance; drinking water; and wastes. BfS also operates 12 air monitoring stations.

The following institutes and agencies also contribute to the Federal IMIS programme for monitoring environmental radioactivity.

National Meteorological Service *(Deutscher Wetterdienst)*
Measurements of air and precipitation, trace analyses, including 40 measurement points.

National Metrology Institute *(Physikalisch-Technische Bundesanstalt)*
Trace analyses, preparation of reference samples,

Federal Institute of Hydrology *(Bundesanstalt für Gewässerkunde*)
Measurements of the radioactivity content of sediments, waters, and particles from Federal watercourses, including 40 measurement points.

Federal Maritime and Hydrographic Agency *(Bundesamt für Seeschifffahrt und Hydrographie)*
Measurements of the radioactivity content of sediments, waters, and particles from the North Sea, from the Baltic Sea and from their coastal waters, including 12 measurement points.

Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries ***(****Johann Heinrich von Thünen-Institut, Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei)*
Radio-ecology of fish, fish products, shellfish, plankton and sea plants.

Max Rubner-Institute, **Federal Research Institute of Nutrition and Food** *(Max Rubner-Institut, Bundesforschungsinstitut für Ernährung und Lebensmittel)*
Monitoring of milk, soil, and foodstuffs and feeding stuffs of both animal and vegetable origin.

6.3 Environmental Radioactivity Monitoring in Saxony

The control of environmental monitoring of radioactitivy is performed by three authorities in Saxony. The Saxon State Ministry of Environment and Agriculture (SMUL) is the "*Land*" authority responsible for radiation protection matters, including monitoring levels of radioactivity in the environment. SMUL deals with public concerns, provides guidance and supervises the other two authorities: the Saxon Agency of Environment and Geology (LfUG) and the state-owned company (UBG) which manages Saxony's environmental monitoring networks. LfUG is the executing authority issuing licenses and controlling the operators. LfUG is also responsible for the content and scope of the monitoring programme for environmental radioactivity and feedstuffs in the context of remediation and closure of former uranium ore mining sites. UBG performs measurements, data collection and controls quality assurance.

In Saxony, monitoring of radioactivity is intended to cover those tasks devolved to it in the framework of IMIS as well as to address environmental radioactivity arising from specific sites, such as Wismut

and the Rossendorf nuclear research centre. The Saxon programme covers both natural and anthropogenic nuclides. Saxon authorities examine on a regular basis food- and feeding-stuffs, tobacco products, drinking water, ground and surface waters, soil and plants. Furthermore, content of radioactivity in discharges and effluents from the nuclear installations at Rossendorf are monitored by air and water sampling.

6.3.1 Control Programme for Wismut GmbH

Requirements for the monitoring of Wismut GmbH sites on the territory of Saxony are based on four legal documents: Federal Radiation Protection Ordinance (StrSchV), Directive on Emission and Immission Monitoring regarding Mining (REI-Bergbau), Order for implementation of programmes for the control of environmental radioactivity in Wismut (published by LfUG) and the Official control programme for the basic programme for Wismut GmbH in its latest version (Az. U2-4686.30/2).

As well as specifying in detail the content of the operator's environmental monitoring programme, the REI-Bergbau also requires that State authorities establish their own measurement programmes to verify the results of the operator's discharge and immissions monitoring programmes. The control measurements are to be performed by bodies not participating in the operator's own monitoring programmes. In Saxony, this measurement control function is executed by the UBG in accordance with the VwV UBG. Two of UBG's laboratories are involved in this monitoring.

The REI-Bergbau requires that independent control programmes include food- and feeding stuffs of vegetable origin. However, it also permits States to omit certain monitoring if it can be demonstrated that certain pathways or materials are not relevant, for example on the grounds of an insignificant contribution to the dose to the public. Based upon relatively stable release conditions from the Wismut sites where experience demonstrates very little year to year fluctuation, the progress made in reduction of radiation due to remediation activities carried out to date, and upon studies carried out by BfS and Wismut GmbH showing a low share of food- and feedstuffs pathways in the overall radiation dose due to the former mining facilities, it was decided by the State regulatory authorities that the authorities' independent monitoring programme need not include food- and feedstuffs.

UBG performs control and comparison measurements mostly of samples taken by Wismut GmbH, although the independent control programme also includes sample taking by UBG which is independent of Wismut's sampling. Table 3 shows the number of monitoring points in the independent control programme.

Table 3. Number of monitoring points in UBG's independent monitoring programme (for 2006) at the Aue/Schlema, Crossen and Königstein sites.

	Aue/Schlema	Crossen	Königstein
Air – emission	1	0	1
Air – immission	10	15	9
Water – emission	7	1	1
Water – immission	19	16	20

Water samples are taken according to procedures accredited in accordance with ISO-17025 whereas the procedures for sampling of airborne dust, soil and radon in air are not yet accredited. Airborne dust samples are only analysed for long-lived alpha-emitting radionuclides. Soil samples are analysed for long-lived gamma-emitting natural radionuclides. Radon samples are analysed for Rn-222 content.

Water sampling includes effluents, precipitation, seepage water, surface water and drinking water. These samples are analysed for different parameters such as several radionuclides from the uranium and thorium series, gross alpha and beta, Rn-222 and long-lived gamma-emitting natural radionuclides. Samples from effluents are analysed by gammaspectrometry and analysed for natural uranium, Ra-226 and Pb-210. Precipitation is analysed by gammaspectrometry. Seepage water and drinking water are analysed for natural uranium, Ra-226 and Pb-210. Surface water and drinking water samples are analysed by gammaspectrometry and analysed for natural uranium and Ra-226. For further information on number of samples and sampling related to remediation activities see table 4.

Table 4. Number of samples taken during 2006 as part of the UBG independent monitoring programme

	γ-Spectro-metry		U^{nat}		Ra-226		Pb-210		LLA		Radon		Nuclear track detector	
	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual
Emission														
Air									4	5	4	4		
Liquid effluent	7	7	40	40	40	40	14	14						
Immission														
1. Air									35	35			58	55
2. Ground surface (Precipitation)	7	7												
5.1 Seepage water			12	12	12	12	1	1						
5.2 Surface water	4	4	25	25	25	25								
5.3Groundwater	1	1	15	14	14	13								
5.4 Drinking water			6	5	6	5	6	5						
Remediation														
transfer of the Crossen slag heap	8	5							8	8	8	8		
Water treatment plant operation in Helmsdorf	10	10							2	2	2	2		
Clean-up of Crossen open ground	2	2	10	9	10	9			4	4	2	2		
Flooding the Königstein mine	20	20	20	20										
Wetland operation in Schlema	1	1	12	12	12	12	1	1						
Wetland operation in Pöhla	1	1	12	12	12	12	1	1						
Water treatment plant operation in Schlema	4	16												

6.4 Wismut's Environmental Radioactivity Monitoring Programme

The scope of the Wismut radiation monitoring programme is to determine:

- radioactive discharges and immissions,
- radiation dose to workers,
- radiation dose to the public living in the surroundings of the remediation sites both during and after remediation activities, and
- whether Wismut's remediation objectives are being met.

The environmental radioactivity monitoring programme focuses on monitoring air and water quality in the vicinity of Wismut facilities. This is done by analyses of ground water and surface water and by air-sampling. As Wismut is a former mining site, monitoring of radioactive mine exhaust air from ventilation shafts and exhaust fans is an important part of the programme. Special attention is paid to radon and the radon monitoring network consisting of some 500 measuring points measures outdoor radon concentrations. Wismut GmbH has also put considerable efforts into research and development of new technology for monitoring the level of natural radionuclides in the environment. About 150 members of Wismut's staff are involved with environmental monitoring, including geotechnical monitoring and monitoring of non-radioactive pollutants.

The current form of Wismut's monitoring programme dates back to 1994 when the then monitoring programme was restructured and divided in two components:

Basic monitoring which takes place independently of remedial actions. It consists of a number of fixed monitoring locations and includes discharge and immission monitoring for soil, air and water.

Remediation monitoring consists of surveillance of the environment during remediation activities. Remediation monitoring programmes form part of licenses to perform specific remediation actions. Upon completion of remediation, measuring points intentified as necessary for long-term measurements are transferred to the Basic Monitoring Programme.

WISMUT GmbH has created extensive data management tools in order to manage the large amount of data related to the monitoring programme. Overall, Wismut GmbH manages around 4500 water measuring points, 450 air measuring points, 30 000 soil measuring points and 10 weather stations. On a yearly basis 30 000 samples are taken and analysed for 300 000 parameters, (including analyses not directly included in the environmental radioactivity monitoring programme such as analyses for process control purposes, or analyses related to non-radioactive, chemical pollutants). After being quality assessed the data is stored in a central database for environmental data.

The Basic Monitoring Programme consists of several monitoring programmes for environmental radioactivity, one for each Wismut site. It is approved by the LfUG in accordance with Article 15 of the AtStrZuVO and is revised on a yearly basis as a function of progress made with remediation.

The chief inspiration for the Basic Monitoring Programme is the REI-Bergbau, which establishes that the operator is responsible for establishing programmes for monitoring of discharges and immissions. It sets out in a very detailed fashion the radionuclides to be monitored, the exposure pathways to be assessed, and the types of environmental compartments to be monitored. The REI-Bergbau specifies minimum sampling frequencies, how samples should be taken, and detection limits that should be obtained. The REI-Bergbau does not require the operator's control programme to include biological samples and consequently Wismut's own programme does not include biological materials.

The Basic Programme includes nine measurement points for water pathway discharges and eleven measurement points for airborne discharges. The Basic Monitoring Programme also contains 332 measurement points for measuring immissions in waters, and 264 measurement points for immissions via air pathways. For water pathways, natural uranium, radium-226 are measured at all measurement points and further nuclides are monitored at selected measurement points.

For air pathways, most of the measuring points (253) within the Basic Programme measure radon. Dust and long-lived alpha nuclides are monitored at 41 measuring points whereas radium-226 in precipated dust is monitored at 45 measuring points. For air pathways Wismut GmbH also has mobile containers equipped with dust samplers and monitoring devices for long-lived alpha emitters, radon, and non-radiological air parameters.

7. LABRATORIES INVOLVED IN THE CONTROL OF WISMUT

7.1 Wismut's Laboratories

7.1.1 Wismut's own laboratories

Wismut's three main laboratories, which have around 40 staff in total, belong administratively to Wismut's Service Department Development/Optimisation/Monitoring. They collaborate closely with other departments which are responsible for sample taking, and data management.

Wismut's central laboratory is situated in Seelingstädt (Thuringia), whilst the two other laboratories are at the Schlema and Königstein sites respectively. Wismut also runs an out-station at Ronneburg for measurement of air filters. For internal QC purposes, or to have access to more precise measurements, Wismut also uses external laboratories, notably the Felsenkeller Laboratory in Dresden, which is part of the VKTA Rossendorf e. V., and IAF *Radiökologie GmbH*, also in Dresden.

The departmental quality manangement system, which applies to all the laboratories, is based upon ISO standard n° 17025, General Requirements for the Competence of Testing and Calibration Laboratories. Most of the methods used in Wismut's environmental control programme have been accredited to ISO-17025 by the German Accreditation Council (*Deutscher Akkreditierungsrat* - DAR). Wismut's environmental monitoring databases are managed following the ISO-9001 Quality Management Standard.

As well as measurements related to the statutory environmental monitoring programme, Wismut's laboratories also carry out process control and non-radioactive measurements. In general, the same analytical methods are used for statutory samples as are used for process control measurements from the same sampling points.

7.1.2 Wismut's sub-contracted laboratories

Felsenkeller Laboratory, Dresden
Felsenkeller laboratory, situated in Dresden, is a part of the *Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V.* (VKTA), which was established to decommission and dismantle the former nuclear installations at the Rossendorf Research Site. At Felsenkeller in Dresden, VKTA has a very low background, underground laboratory suitable for analysis of very low levels of radioactivity.

IAF Radioökologie GmbH, Dresden
IAF's domain of activity includes the analysis of radioactivity in the environment both for private companies and the public sector.

7.2 UBG

UBG is a state enterprise under the control of the LfUG with 160 staff distributed across 9 locations. After re-unification the LfUG (and later the UBG) took over the existing monitoring tasks from the former GDR-authorities. Qualitatively and quantatively the extent of the controls has greatly increased since that time. It carries out a number of technical activities relating to monitoring of the environment in Saxony, although mostly not relating to environmental radioactivity. Environmental radioactivity measurements are the responsibility of the Environmental Radioactivity Division, which has 21 staff at two locations.

As described in Section 6 above, UBG carries out independent measurements to verify Wismut GmbH's statutory environmental programme. In the radiological/nuclear field, it also carries out food-stuffs monitoring and has responsibilities in relation to monitoring of radon in buildings and illicit trafficking of nuclear materials.

Two UBG laboratories are involved in control of the Wismut monitoring programme, one in Radebeul and the other in Chemnitz. They have a common QA programme and have ISO-17025 accreditations from DAR. UBG also follows at corporate level ISO 9001 and ISO14001 QA systems. In general both the Radebeul and Chemnitz laboratories are capable of performing similar analyses using similar equipment, although in practice there is some degree of specialisation between the laboratories based for instance on geographical proximity to the sampling point. However, on cost grounds, uranium analyses are concentrated at the Radebeul site.

8. LABORATORY VISITS

8.1 UBG laboratories

8.1.1 Introduction

The UBG laboratories in Chemnitz and Radebeul were visited by the verification team. During the visit to the Radebeul laboratory, the verification team concentrated upon the more administrative aspects of the work of the UBG such as sample management, QA, data evaluation and participation in

inter-comparison exercises, whereas the team concentrated on measurement methods during the visit to the Chemnitz laboratory.

8.1.2 UBG Radebeul

Sample Management and Quality Assurance

The verification team discussed sampling planning and sample management in relation to the programme for control of Wismut's own programme. It was explained that the aim of UBG's control programme is to gain assurance as to the correctness of the values reported by Wismut on the basis of parallel measurements of a sub-set of the samples in Wismut's sampling programme. The control programme reflects the requirements of the REI-Bergbau, as well as an implementation order from the LfUG. Indicatively, 5 – 10% of Wismut's samples are subjected to parallel measurements by UBG. Normally, the ministry, SMUL, does not directly intervene in the drawing up of the sampling programme.

Most samples analysed by UBG are parallel to Wismut's own samples and are taken by Wismut. Scheduling of sample taking is agreed annually with Wismut and so in general Wismut know which samples will be subject to parallel control measurements. However, UBG do sometimes sample jointly with Wismut. They also take a limited number of unannounced samples although UBG from time to time jointly sample with Wismut. In addition, UBG also take a limited number of samples from points where there is no corresponding Wismut sample. UBG also operate their own continuous monitoring station on the Elbe. Apart from the evaluation of radon dosimeters which is sub-contracted to Altrac Berlin, all samples in UBG's Wismut control programme are analysed in the UBG laboratories.

A key component of the UBG programme is an annual inter-comparison exercise, including comparisons between laboratories and between analytical methods. Once a year, UBG measures samples from each of the liquid discharge points at Wismut by four independent measurement techniques (liquid scintillation counting, gamma spectroscopy, alpha spectroscopy, laser phosphoresence) in order to confirm the absence of systematic errors in the routinely applied techniques for determination of uranium in water.

Samples arrive already bearing a unique identification number, accompanied by a sample taking record prepared by Wismut. Upon receipt at one of the UBG laboratories, samples are entered in the log book and receive a laboratory identifier. All sample bottles are supplied by Wismut. The measurement results are entered to the UBG LIMS, and a paper copy is approved for issue at the same time; UBG's master copy being held at the Radebeul site. However, intermediate steps in the calculation of results are generally carried out outside of the LIMS.

> *Verification activities with respect to sample reception and registration did not give rise to any particular remarks.*

Measured results are corrected for radioactive decay in order to facilitate comparison with Wismut results. UBG has direct read access to Wismut's results database, although comparisons normally await formal release of Wismut's results. Comparison of individual UBG and Wismut results is carried out manually by the laboratory leader. Acceptance or rejection of individual results is based upon a standard set of acceptance ranges rather than a comparison taking account of the measurement uncertainties for the individual measurements. For instance, Wismut's uranium results are accepted if they lie within an interval which is derived from the 10% mean reproducibility variation coefficient. The acceptable range is said to be determined from national inter-comparison exercises involving twenty laboratories performing similar measurements.

All of UBG's measurement standards are obtained either from the German Calibration Service (DKD) or from PTB in Braunschweig (PTB – Physikalisch-Technische Bundesanstat – is the reponsible German institution for metrology) . UBG also regularly participate in several national inter-comparison exercises concerning measurements of environmental radioactivity, including exercises organised by the German Federal Radiation Protection Office (BfS), the Federal Hydrology Institute, and the German Food Safety Office. UBG also participate in intercomparison exercises organised by the International Elbe Commission. BfS report laboratories' performance in intercomparison exercises

to the laboratories' supervisory authorities. UBG also participate in an intercomparison exercise organised by the IAEA.

At the corporate level, UBG operates according to the ISO 9001 Quality Management standard and to the ISO 14001 Environmental Standard. Some of UBG's operations, including measurements of environmental radioactivity, also follow the requirements of ISO 17025 (General requirements for the competence of testing laboratories). Most of the analytical procedures used in the programme for controlling Wismut have been accredited by the German Accreditation Council (DAR), and it is intended to obtain accreditation for further analyses when the accreditation is next renewed. The verification team randomly checked document control of a small number of laboratory procedures, examined purchasing procedures and staff training, and also verified that Management Reviews, and internal audits had taken place in accordance with ISO 9001 requirements. No problems were found, although this constitutes a very limited examination of the system and does not constitute a full QA audit.

Laboratory Equipment

The verification team also visited the measurement equipment used at UBG Radebeul. Uranium in water is determined by the laser phosphorescence technique, using a Chemchek Kinetic Phosphoresence Analyser (model n°. KPA-11). Before measurement, a complexing agent is added to the sample. Samples are measured in high quality, quartz glass cuvettes and are subjected to 1000 laser pulses of duration 4 ns and wavelength 425 nm. The instrument's detection limit is 0,1 ppb. Cuvettes are re-used after cleaning and checking.

During a subsequent visit to Wismut's own laboratory (see also 8.2.1.), the verification team observed that Wismut employ the same instrument to measure the same types of samples, which are very often common samples. Notwithstanding quality control measures intended to establish the absence of systematic measurement errors, such as the annual inter-method comparisons, the fact that the operator and the control authority use the same physical measurement principle, and the same make and model of measurement instrument to measure a common sample points to a reduced independence of this aspect of the control programme.

> *The Verification team therefore invites the authorities to examine means of increasing the indepence of the operator's programme and the control programme or to examine means of providing increased confidence in the absence of any significant systematic uncertainties associated with this measurement method.*

The team also visited the TRICARB 3170TR/SL, a liquid scintillation counter used for measurements of radium-226 with Ba-133 as yield tracer. The team examined specifically the analysis of samples taken from discharge point k-0001 at Königstein. The team also took the opportunity to investigate UBG's policy regarding instrument QC, such as calibration frequency, the frequency of checking the calibration of instruments, and the frequency of measurement of standards and blank samples. The team witnessed preparation of a sample from measurement point 109 during their visit to the radiochemistry preparation laboratory.

> *These verification activities lead to no particular remarks on the part of the Verification Team.*

The Verification team noted the presence of a gamma probe belonging to the Federal (BfS) surveillance network, installed in the grounds of the UBG premises. The probe has a measurement range of 10 nSv/h up to 10 Sv/h. The probe is checked annually by BfS.

In addition, vegetation is sampled from a nearby special area of 4 m².

8.1.3 UBG Chemnitz

Laboratory Equipment

The laboratory's equipment is similar to that in the sister laboratory in Radebeul. Determinations of Wismut samples are made by alpha and gamma spectroscopy and by liquid scintillation counting and

by gross alpha counting. Gamma spectroscopy can be used as a check on the results obtained through alpha spectroscopy, for instance for uranium determinations.

Alpha spectrometry

The verification team followed sample preparation of a water sample from the radio-chemical preparation laboratory through to measurement in the spectroscopy laboratory. U-232 is added in the radiochemistry laboratory as a tracer in the case of uranium samples from Wismut. The sample is then deposited upon a planchet using an electrolysis cell (with platinum electrode), ready for measurement in one of the alpha spectrometers. Each group of measurements is followed by a measurement of a blank planchet prepared in the Radiochemistry Laboratory using the same reagents and the same electrolysis cell.

The verification team noted that the alpha laboratory is well equipped with Ortec Octète alpha detectors. Samples are normally counted (measured) until the statistical error based upon counting statistics is less than 5% relative.

Air filter samples are measured directly for gross alpha activity on a low-background proportional counter (Eurisys Mini 20) without any preparation. An empirical correction for self-absorption is introduced based upon the mass of the dust deposited on the filters. Air filters are normally received by UBG up to two weeks after they were taken, which is not the optimal situation because of ingrowth of Po-210 from Pb-210 deposited on the filter in addition to the long-lived alpha emitters which are to be determined. Filters are therefore measured at montly intervals over a three month period in order to be able to correct results back to the date of sampling. It was confirmed that the glass fibre filters used for air samples do not contain significant amounts of intrinsic alpha radioactivity.

Gamma spectrometry

Four gamma detectors are used for gamma measurements (although only three of them are used for Wismut samples).

- gamma 1 is an HPGe 35 pc N coaxial detector, from Eurisys and of the type 35-195-R. The amplifier is manufactured by Aptec (model 6300).
- gamma 2 is an HPGe 35 pc N coaxial detector, from Eurisys and of the type 35-195-R. The amplifier is manufactured by Aptec (model 6300).
- gamma 3 is an HPGe 45 pc N planar detector, from Eurisys Mesures and of the type EGMP 80-30-R. The amplifier is also manufactured by Eurisys Mesures.
- gamma 4 is an HPGe 30 pc P coaxial detector, from Silena, remanufactured by DSG Detector Systems. The amplifier is manufactured by Canberra (model 2024). The laboratory mainly uses this detector for analysis in the range 100 keV to 2000 keV.

The verification team also noted that to reduce measurement background the gamma detectors are surrounded by 15 cm of lead (of which the innermost 2 cm are of special low activity grade). The measurement chambers are furthermore protected by a thin copper liner to reduce the effects of Pb-210 gamma rays (46.5 keV), bremsstrahlung from Bi-210 and lead X-rays (all from the lead shield).

For gamma spectroscopy, the laboratory uses Ortec Interwinner software which includes a measurement QC package.

The gamma laboratory has a controlled climate to ensure the electronic stability of the machines. The laboratory is also fitted with a special ventilation system which reduces the radon background by creating an overpressure in the laboratory with respect to the outside of the building. A Genitron AlphaGUARD radon-in-air monitor continuously monitors the radon background in the laboratory.

> *Verification activities with respect to UBG Chemnitz do not give rise to any particular remarks on the part of the Verification Team.*

8.2 WISMUT's laboratories

8.2.1 Laboratory in Seelingstädt

Fifty-seven staff (including staff employed on sample taking) work in Wismut's central laboratory at Seelingstädt (Thuringia), which is housed in a former operations building. Sixty to seventy percent of samples analysed in Wismut laboratories are analysed here. However, Wismut have no facilities for evaluating radon dosimeters, and thus Wismut's involvement in their evaluation is limited to organising their shipment to the external laboratory where they will be assessed.

The Verification team followed the flow of samples through the laboratory, commencing with a visit to the sampling preparation area where the team examined practices relating to receipt and pre-measurement preparation of samples such as sub-sampling, filtration and conservation. A team of three persons is assigned to sample receipt and samples may be received twenty-four hours a day, seven days a week. All samples received are already labelled with pre-printed labels placed upon the empty sample containers.

The actual measurement technique chosen for each sample is based in part upon expectations for the sampling point in question, and partly upon the results of the initial measurement of the sample.

Alpha measurement

The team visited the preparation laboratory followed by the analysis laboratory. In the standards preparation laboratory the team observed the preparation of calibration standards. The team requested and were given the PTB certificate for the radium calibration solution.

For alpha measurements (radium-226) the laboratory uses a multi low level alpha/beta counter FAG FHT 770 T which offers complete software for automatically calculated measuring time for set limit values. The instrument has a high sensitivity and a low background. Eighty percent of the measurement results are below 100 mBq/l.

The calibration of the device is checked daily following the Chemchek QA routine and a new calibration is carried out if necessary. In any case a calibration is undertaken every three months.

The QA parameters are specified in the REI-Bergbau.

Receipt and registration of samples

The laboratory principally deals with samples from the process rather than the monitoring programme, though both types of samples are analysed in the same manner.

The laboratory has developed detailed instruction manuals for each instrument and all chemicals used are first tested.

For sample taking each employee receives an annual training.

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

ICP-OES

The primary technique used for liquid samples is ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry). Atoms are electronically excited in the plasma and emit radiation characteristic of the element(s) present when they return to the ground state. Uranium in water is determined by KPA (Kinetic Phosphorescence Analysis). Thereby, lacer induced phosphorescence light is emitted by uranium atoms.

The Seelingstädt laboratory is equipped with two ICP-OES instruments, both manufactured by the Jobin Yvon company, an Ultima 2 instrument and an older model 385 instrument.

Generally, little preparation of samples is needed before measurement, although discharge water samples may need the application of vigourous chemistry to ensure that uranium present is completely dissolved. Liquid samples are directly introduced into the argon plasma via a nebuliser. The instrument is capable of measuring as low as concentrations of less than 1 ppb (less than

1 microgramme per litre). The ICP-OES is also used to establish the concentration of heavy metals other than the radioactive ones. The single largest sample stream is composed of process control samples, and in fact the instrument is not normally used for samples on the Wismut monitoring programme.

8.2.2 Filter Measurement Station at Ronneburg.

The laboratory measures the particles on filters (total alpha). All filters come from the Wismut site or from either Schlema or Königstein. After measurement the filters are kept for 1 month.

The laboratory processes around 7000 filters per year of which 10% are checked by BfS.

The filters are first dried for 24 hours before being weighed. The scales are tested every 2 years. Following weighing the filters are stored for 7 days to allow the short lived products to decay.

The team verified the calibration certificates for the weighing scales.

The laboratory employs some EBERLINE/FAG alpha counters (multi low level counter FHT 770 T). The counting gas used is argon/methane. The FHT 770 T offers complete software for automatically calculated measuring time for set detection limit values. The instrument has high sensitivity and low background, and is available with 6 or 12 gas flow counters allowing for simultaneous sample measurement.

The alpha counter has 12 spaces for small filters (47 mm diameter) and in another counter 6 spaces for large filters (150 mm diameter). The analysis takes 2 hours regardless of whether it is a sample or a blank.

Blanks are measured once per day and sometimes before each measurement. Calibration is carried out monthly using natural uranium.

The team noted that there was no forced ventilation system, only a window. Given that the building is situated in an area where spoil heap remediation is still ongoing, the risk of exteral dusts entering the laboratory and interfering with measurements is not negligible.

> *The Verification Team recommends that the operator investigate infrastructure improvements to provide protection against the ingress of dust from outside at the Ronneburg measurement station.*

8.3 FELSENKELLER Laboratory

VKTA operate the Accredited Laboratory for Environmental and Radionuclide Analytics (accreditation number: DAP-P-02.206-00-92-21 given by the DAR). At the Felsenkeller site the laboratory undertakes low level measurements and those linked to decommissioning. To reduce the effect of cosmic radiation during measurement the laboratory is situated below 15 m of rock. The following methods and equipment are applied and used:

- in-situ integral methods for radioactivity measurement (alpha, beta, ambient dose rate)
- radiochemical separation methods
- alpha spectrometry
- beta measurement (by LSC)
- gamma spectrometry
- in situ gamma spectrometry
- emanometric analysis
- energy-dispersive X-ray fluorescence analysis (RFA)
- radon measuring equipment
- measuring of the total of gamma radiation (Clearance Monitor Facility)

The laboratory successfully took part in inter laboratory comparisons notably concerning cobalt-60 activity in steel, together with HADES (Belgium), LSCE Modane (France) and LNGS (Gran Sasso, Italy).

The laboratory seems to be "state of the art" concerning the low level gamma measurement.

For tritium measurements a Wallac Quantulus 1220 ultra low level liquid scintillation spectrometer is used. Maximum physical sample volume is 20 ml, but in extraction and enrichment techniques radiation may originate from larger volumes and sensitivity is improved accordingly. The Quantulus device is used for measurement of extreme low concentrations.

In general 60 samples are sent each year by Wismut, each sample consisting of a 1 litre bottle.

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

9. SITE VISITS

Wismut's three principal remediation sites in Saxony; Königstein, Bad Schlema, and Crossen were visited in order to verify the extent of sample taking, the equipment deployed, the effectiveness of sampling procedures in obtaining representative samples: both in relation to Wismut's own programme and to the the control programme executed on behalf of the Saxon authorities. Wismut's headquarters were also visited in order to verify organisational and administrative issues important to the effectiveness of Wismut's own programme such as sample management, result reporting, data management, management of sampling points, and corporate quality assurance.

Appendix 2 lists in detail the sampling points visited during the course of the visit. Two types of sampling points were visited, sampling points for discharges (emissions) and sampling points for measuring the spread of radioactivity from Wismut into the surrounding environment (immissions). Some of the latter sampling points may be situated several kilometres from the named Wismut site.

Sampling points for verification were selected in order to verify a representative selection of sampling devices, and the different kinds of sampling performed by Wismut and not to verify the approaches applied at the individual visited sites. The REI-Bergbau distinguishes between immission and emission monitoring and Wismut distinguishes between routine monitoring and ad-hoc monitoring related to specific remediation activities. According to a system elaborated in 1995 with GRS, Wismut further classifies sampling points as being of Type A (intensively monitored point), Type B (for the measurement of trends), or Type C (environmental background monitoring). The sampling points visited include representatives of all types of sampling point.

As well as addressing radiological hazards, Wismut's remediation programme also addresses the chemical pollution, as well as other hazards such as preventing land slips at spoil heaps or bursting of dams at tailings ponds. Wismut's monitoring programme also includes sample taking in relation to these activities, particularly chemical pollutants, but such sampling is outside the scope of an Article 35 Verification.

Sampling points are identified according to Wismut's nomenclature. Access was granted to all the sampling points requested by the verification team. The verification activities included witnessing of demonstrations of sampling equipment.

9.1 Königstein

The Königstein site is situated near the Königstein fortress in south-eastern Saxony, and its nearest point is only 600 m from the Elbe river. Conventional underground uranium mining began there in 1967, and between 1979 and 1984 a gradual switch-over to in-situ leaching took place. This involved injection of sulphuric acid into the underground ore body, followed by pumping of the leachate to the surface for chemical extraction of the dissolved uranium. The cessation of mining in 1991 left behind a particularly difficult environmental problem, owing to the proximity of drinking water aquifers and the Elbe. In 2007 the water in the mine is still acidic and may contain up to 200 ppm of dissolved uranium. 185 sampling wells have been dug in order to be able to take samples of subterranean waters from various depths around the site, the deepest well descending to a depth of 291 m.

As part of the remediation project, a water treatment plant with a throughput of up to 650 m³/h was constructed in order to clean up waters from the mine before discharge (via a precipitation pond) to the

Elbe. This is the only discharge point from the site. Tens of tonnes a year of uranium are still recovered during clean up of the mine waters. The water treatment plant also produces around a thousand tonnes a year of sludges containing low levels of radium and uranium. These sludges, along with other solid wastes from the Königstein site are disposed of at a former spoil heap at the site (the Schüsselgrundhalde). The water treatment plant also treats all rainwater which falls on the site, collected seepage water, and sanitary effluents from the site.

A total of seven sampling points were verified in and around the Königstein site.

Point k-0001 is the discharge point from the precipitation pond which receives the treated water from the water treatment plant. Discharges of uranium and radium from this point into the Elbe river must not exceed the annual limits and the concentration limits set out in the operating licence granted by the LfUG. An automated sampling station takes hourly samples from the discharges for process control purposes. The sampling station also provides for continuous monitoring of the pH of the discharge for process control purposes. A back-up water sampler is also present in case of problems with the sampling station.

In order to demonstrate compliance with the licence requirements, an hourly sample of the discharged water is taken, and bulked to provide a daily sample. Seven days worth of such samples are bulked to produce a representative weekly sample for measurement. The team found the equipment and the operational procedures to be satisfactory.

A flow-meter is used to verify/measure the total volume of liquid discharged, and hence the total amounts of uranium and radium. The verification team checked that the flow-meter was covered by a valid calibration certificate.

Prior to discharge to the Pehna brook which flows directly into the Elbe, the cleaned up water from the water treatment plant is held temporarily in a settling pond, partly to allow any suspended solids to settle out and partly as security in case of a breakthrough of uranium or radium which could cause the discharge limits to be breached.

The discharge from this settling pond passes via a pipeline to the Pehna brook (sampling point k-0002) just before it enters the Elbe. The verification team witnessed a demonstration of manual sample taking at this point. The team found the sampling procedure to be satisfactory.

K-66033 is a purpose built deep well for sampling an aquifer below the Königstein site. Samples can be taken at depths of up to 210 m from this well. Normally, to sample at such depths a fixed drilling rig would be required. However, Wismut have developed a mobile, vehicle mounted rig especially for sampling of the 50 deep wells at Königstein. Once the sampling head attains the required depth, water is pumped from the sampling point to the surface until the sample consists of water which is representative for the ground water under investigation. One indication that water is representative is a constant conductivity. Sampling wells incorporate features such as screen and traps to ensure the quality of the sample drawn. The verification team were able to satisfactorily verify administrative aspects of the sampling procedure at this point.

Deep sampling well K-66036, in the vicinity of Königstein Castle was also visited. As the same sampling technique is used as at point K-66033, there was no need to witness a demonstration of sample taking once more.

Sampling Point WB4, which is an authorised discharge point for airborne discharges arising from the forced ventilation of the mine workings, is used to sample the air discharged from the mine's number 4 shaft. The sampling point serves to evaluate the flowrate of air escaping from the shaft, as well as the concentration in this air of radon, dust, and long-lived alpha emitters. The operational licence for Königstein sets limits on annual discharges of radon-222 and long lived alpha emitters for all three remaining shafts.

The verification team witnessed the drawing of a sample of air through an iso-kinetic dust sampler rig. Air samples are drawn four times per year from the shaft in order to demonstrate compliance with the licence. Air volumes are established by means of anemometers. The radon concentration is recorded using a Genitron AlphaGUARD PQ 2000 continuous radon monitor. The sample represents a volume of around 20 m^3 of air and typically takes around 3 hours to be drawn through the glass fibre filter. The dust concentration is calculated from the weight of solids collected by the filter.

K-0008 is a sampling point, situated in the artificial basin which collects seepage waters from the Schüsselgrund spoil heap. The waters collected in the basin are fed to the water treatment plant. The water in the basin is relatively acidic, with a typical pH in the range 2-3. The manual sample taking procedure was witnessed.

Verification does not give rise to recommendations.

9.2 Wismut GmbH, Chemnitz

Wismut GmbH has its headquarters in Chemnitz. The verification team met with representatives of the environmental monitoring, QA, and data management departments.

The number of samples in Wismut's sampling programme is too high to permit the keeping of archive samples for every sample taken. Nonetheless, all samples are retained until the Wismut LIMS (Laboratory Information Management System) has performed a plausibility check on the measurement result in question. The plausibility check operates on three levels, check of other sample parameters e.g. pH to identify problems with the sample itself, stoichiometric and arithmetic mass balances of other analytes, and plausibility in respect of previous measurement results from the same sampling point. Similarly, samples where a regulatory body has taken a parallel sample are held until confirmation that there was no significant measurement difference.

The corporate QA manual is available electronically at the workplace, although paper copies of the full manual are held at selected locations. Wismut's Licensing Department is responsible for translating the regulators' requirements into operational procedures.

In relation to monitoring of environmental radioactivity, regulatory control of Wismut is exercised by site visits from the LfUG and by the taking and measurement of parallel samples by the UBG of a sub-set of all the Wismut sampling points. The Saxon Environment Ministry may also undertake checks through sub-contractors.

Permits-to-operate are granted on an object related basis, and are normally granted for a limited time. Permits from the authorities, maps, remediation locations and general environmental information are all managed in what is known as the Distribution Database. Checks for the continuing validity of permits are carried out whenever the Wismut monitoring programme is updated. Compliance with permits is demonstrated by Wismut through reporting via the annual Emissions Reports or via specific reports where necessary. The Distribution Database also contains other relevant information such as maps.

The verification team randomly selected three permits-to-operate covering the Schlema site for verification during the subsequent site and laboratory visit that the pertinent provisions were being respected by Wismut and were being followed up adequately by the authorities having an oversight role. The team found no evidence to suggest non-respect by Wismut of the permit provisions or of a lack of adequate follow up by the oversight authorities.

A second system of databases is known as the Production Database. It includes Wismut's LIMS; and modules for managing sampling points, geological information, analytical methods, raw laboratory data, limits, and measurement results. The data in the system is subject to a number of measures to ensure that data is not lost in the event of system failure. The server hard-disks operate in RAID configuration, every night the entire data-base is downloaded, and back-up tapes are kept in a fire-proof safe at another location. The databases can be accessed from 70 work-stations at Wismut. As well as managing measurement results arising from the Wismut monitoring programme, it also manages Wismut's process control samples.

Wismut personnel performed a demonstration of the system displaying information related to a sampling point chosen by the verification team, M-0039 – the sampling point of the discharge from the water treatment plant at the Crossen site.

The Production and Distribution database systems manage and archive an impressive quantity of information. There are over 2000 locations where remediation is being carried out, covered by 6000 permits, and several thousand related documents. As for monitoring points, there are 4500 points used for water sampling, air sampling is performed at 450 locations, soil samples are taken from 30 000

points, and Wismut operate 10 weather stations. The system manages 30 000 samples per year, (including process control samples and non-radioactive samples). These samples in turn generate 300 000 parameters to be analysed.

Verification does not give rise to recommendations. The Verification Team takes note of the technical achievement of these sytems.

9.3 Wismut GmbH, Crossen

The Crossen site is situated in south-western Saxony, near to the town of Zwickau. Formerly, it was the site of a uranium ore processing plant, which was operational between 1950 and the end of SDAG Wismut's operations in 1989. During its operational life, a total of 74 million tonnes of ore was processed, yielding around 77 000 tonnes of uranium. At the start of the Wismut GmbH remediation project, the chief remediation challenges to be dealt with were the 18 million tonne slag heap, the disused ore processing plant, a 200 hectare tailings ponds and a 20 hectare tailings pond. The former tailings pond contained 56 million tonnes of solids with a depth of up to 55 m.

The chief remediation projects undertaken by Wismut at Crossen concern: decommissioning and demolition of the processing plant; relocation of the spoil heap into the Helmsdorf tailings pond using a pipe conveyor; removal and treatment of the water in the tailings ponds which contain around 10 ppm of uranium; and stabilisation and capping of the ponds.

The team visited the following sampling points in and around the Crossen site.

M-039	Controlled discharges of U and Ra-226 to surface waters	Helmsdorf Water Treatment Plant
M-204	Diffuse seepage to surface waters	Oberrothenbacher Bach
217.00	Ground level radon emissions	Oberrothenbach
215.15	Ra-226 in precipitation	Private house, main street, Crossen village

At the time of the visit the Crossen Water Treatment Plant had treated a total of 17 million tonnes of pond water, the main pollutants in which are uranium, arsenic and radium. The capacity of the plant is in the range 50 to 200 m^3/h. In addition to pond water the plant also treats locally arising seepage water and water discharged from the radiation-contamination controlled zone at Crossen.

The verification team visited the discharge point from the Water Treatment Plant. Samples are taken manually on a daily basis for process control purposes and on a weekly basis for the uranium and radium balance to demonstrate compliance with the permit-to-operate. The verification team checked that the flow-meter used for balancing discharges was within its calibration.

Although, the other sampling points in the programme were off-site, the team made a short detour to observe the remediation work on the 220 hectare tailings pond, where current work includes reducing the slope of the pond dams to stabilise them.

There are a total of 36 sampling points around the Crossen site for measuring radon immissions. The team visited point 217.00, where a passive dosimeter (track etch) is mounted for measuring levels of radon in the open, near to the ground. The dosimeter is located in the garden of a private house in the village of Oberrothenbach.

The alpha decay of radon decay products deposited on the film produces tracks in the film which can be counted after chemical etching. The film used at this particular point is sent to BfS Berlin for development and evaluation.

The films are changed twice per year to give a summer film and a winter film, although experience to date shows little difference between summer and winter radon levels. Since remediation work started at Crossen, the atmospheric radon concentration measured at this point has roughly halved.

There are 14 points around Crossen for collecting precipitation samples for radium-226 determination. The team visited one such sampling point located in the garden of a private house in Crossen village, where they discussed the sample taking procedure. A sampling point for taking dust samples is also

situated at this location. Precipitation is collected in an open, cylindrical collector vessel with a surface area of 0.177 m². The vessel is emptied every quarter. The collected precipitation is sieved to remove gross solids, which along with the sieve are washed in situ with distilled water and the washings collected.

The samples are routinely analysed for radium-226 content, and, if a threshold value is exceeded in the laboratory for the radium-226 concentration, the U-238 and Pb-210 concentrations in the sample are also measured.

Sampling Point M-204 is located on a small brook known as the Oberrothenbacher Bach, near the village of Oberrothenbach which lies roughly between the former mill site at Crossen, and the large Helmsdorf and Dänkritz tailings ponds. The point is intended above all for monitoring of diffuse seepage from the Helmsdorf tailings pond and hence of incipient threats to nearby aquifers (but not drinking water aquifers).

An engineered channel has been fabricated, allowing measurements of flow through the stream using the installed flowmeter. The sampling channel includes equipment for continuous monitoring of conductivity and pH of the water in the brook. Any significant change in either could be indicative of increased contaminated seepage into the brook. The measurements are sent on-line to Wismut Ronneburg.

Samples for the Wismut programme for monitoring of environmental radioactivity are taken manually from this sampling point.

Verification does not give rise to recommendations.

9.4 Wismut GmbH, Schlema

The verification team selected Schlema as representative of remediation of deep, underground mining. Between 1947 and 1991 uranium ore was mined from 54 different shafts at a depth as low as 1800 m below the surface, from a total of 4200 km of shafts and tunnels. During its operational life 80.000 tonnes of uranium were produced. Ore formations containing as little as 300 ppm uranium were exploited, resulting in enormous quantities of waste rock being produced. The site includes a tailings pond, later used as a precipitation pond for mine water.

As might be expected, the environmental impact was great. At the commencement of the Wismut remediation project, the engineers were confronted with 47 million m³ of spoil heaps, some of which were sited near to residential locations. The tailings / precipitation pond contained 300 000 m³ of radioactive sludges, and the mine ventilation shafts were emitting 900 TBq/year of radon-222 (max. in 1986: 1675 TBq); locally high radon concentrations caused by radon leaking from uncovered spoil heaps were found, as well as leakage and seepage of untreated water from mines. Prior to the arrival of uranium miners, Schlema had been a spa town (at the time it was the worlds richest radium spa), earning its living from tourism, although in the middle-ages there was a silver mine at Schlema.

The chief remediation activities at Schlema are: controlled flooding of the mine shafts; treatment of mine and seepage waters; relocation of spoil heaps or reshaping and covering spoil heaps with a 1 m thick layer of soil. At the time of the visit, closure by controlled flooding was 95% complete and 1150 m³/hour of mine waters containing around 5 ppm of uranium were being treated at the Schlema water treatment plant. An underground buffer for temporary holding of mine waters is currently being prepared in order to match water treatment capacity and demand.

The sampling points and other locations in and around Schlema visited by the team are listed in the table below. Some locations are sampling points and some were locations associated with monitoring related to specific remediation objects. Additionally, some locations where remediation was complete or near complete were included in order to address issues related to the long-term monitoring of locations where remediation was complete and had been completed with unrestricted or partially restricted permitted usages in order to address the issue of long-term monitoring once remediated sites are authorised for partial or full re-use. The question is particularly pertinent given that the Wismut remediation project is nearing its end.

Sampling Point ID	Function	location	Notes
Wetland 371, m-538	Monitoring of discharges from artificial wetland	Near mine shaft #371	Wetland created for experimental purposes
m3386A	Sampling of near surface (25 m) ground-waters	Near mine shaft #371	Demonstration of sampling and in-situ determination of water parameters
N/A	Disposal site for contaminated solid waste		Example of licensed remediation monitoring
Large mobile air monitoring station (Messcontainer)	*inter alia* Rn-222, dust and LLA from ongoing remediation activities	heap 66/207	
m-555	Discharge from Water Treatment Plant	Schlema Water Treatment Plant	
Mobile air monitoring station	*inter alia* Rn-222 & LLA	heap 66/207	Used particularly for workplace monitoring
N/A	Rn	Spoil heap 38-new	Not yet released after remediation, owing to higher than expected Rn exhalation; No visit to the site, but explanations given from a vantage point at heap 66/207
Overview from Hammerberghalde around the remediation area	Rn and water monitoring	Hammerberghalde	Not yet completely released after remediation, owing to locally higher than expected Rn exhalation; requiring further investigation and countermeasures
m-108X; 511.32	U and Ra-226 in water; Rn-222 plus LLA	Area below the dam of the Borbach Tailings Pond	All seepage water from the Borbach valley passes through here

N/A … not applicable

The verification team witnessed a demonstration of sampling at sampling point m-3386, which is a 25 m deep engineered well for sampling ground waters in the vicinity of shaft 371. There are 50 or so such shallow wells around the Schlema site.

A vertical well crosses a section 10 m in length through which ground water flows at a rate of about 500 litres per hour. At 24 m depth a filter screen is fitted. Groundwater at this location is contaminated with uranium to levels of up to 1 mg/l, and the water is from slightly acidic to neutral. The sample is taken using a pumping rig installed in a van. In essence, water from the sampling point is pumped until the sample consists of freshly pumped water.

The team also visited two locations to examine technical aspects of remediation or to examine the operation of licensing of operations by the LfUG.

Wetland 371

Wetland 371 is an experimental set-up to evaluate whether passive wetlands could be used in the future for treatment of contaminated waters, as a replacement or complement for a water treatment plant.

A permit to operate granted by LfUG had been randomly selected by the verification team in order to assess how the LfUG exercises in practice its oversight role in respect of Wismut. The selected permit concerned authorisation to deploy new technology at the Schlema disposal site for radioactive waste. LfUG have an employee based permanently at the site who is in permanent contact with Wismut. LfUG also employ the services of independent experts (Gutachter) to provide advice when necessary. The permits covering operation of the waste facility include provisions on monitoring of run-off water – remediation monitoring according to Wismut's classification. Unfortunately, the particular permit randomly selected for verification proved to have no provisions concerning monitoring, so an on-the-spot verification of LfUG oversight activities in relation to the Wismut monitoring programme was not possible in this instance.

The Verification team also examined the revised permit to operate for the water treatment plant. Prior to authorising a change in the process, LfUG had commissioned studies by independent experts to investigate the acceptability of the modified process. It was also noted that the discharges from the water treatment plant are subject to unannounced sampling by UBG acting on behalf of LfUG.

The team also visited a large mobile measurement 'container' situated near to spoil heap 66/207. It is a transportable cabin fitted out with sampling and measurement equipment. The cabin is hermetically sealed and is equipped with air conditioning to ensure constant ambient conditions for the installed equipment used for continuous sampling of airborne dust concentrations, airborne long-lived alpha emitters, and radon. Wismut also deploy 15 smaller versions known as "Mini-Mess-Containers" used mainly for workplace related monitoring rather than for environmental monitoring, and the team also took the opportunity to examine one of the small ones.

The team also viewed remediation activities from the viewpoint of Hammerberg, which is the first spoil heap where remediation was completed, although subsequent monitoring indicates a higher than expected radon exhalation rate so that further monitoring and remediation measures will likely be required. The spoil heap is subject to monitoring by Wismut of the radon exhalation rate (measured using solid state track detectors placed < 10 cm above ground) as well as monitoring of seepage waters and ground waters. Wismut is required to report the monitoring results annually to LfUG.

Low specific activity soil is used for the top layer of the soil used to cover the spoil heap. The effectiveness of the covering layer is checked by gamma dose rate measurements and measurements of the radon exhalation rate. Although remediation is complete, the land is not released for unrestricted use. For example, forestry is not permitted since tree roots could damage the layer of soil used to seal the spoil heap.

Verification does not give rise to recommendations.

Borbach Dam

All seepage water from the Borbachtal catchment area is collected at the Borbach dam before being fed to the Zwickauer Mulde. The collected water is considered as a discharge and hence there is a sampling point here for water sampling, including measurements of volume, chemical quality and radioactive discharges. At the same location there is also a sampling point for air immissions (radon-222 and alpha bearing dusts). Additionally, at the same location there are three wells for checking of near surface (<50 m deep) groundwaters.

Verification does not give rise to recommendations.

10. 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 before the start and during the verification, was useful. The information provided and the outcome of the verification activities led to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil in relation to Wismut operations in the Land of Saxony, Germany were in place. The Commission's Services could verify the operation and efficiency of these facilities.

(2) The verification team was able to verify that in the Land of Saxony discharge monitoring and monitoring of the environmental effects of releases from Wismut sites are part of a well established routine programme, which includes independent verification of the monitoring measurements.

(3) A recommendation and a suggestion have been formulated. They aim at improving some aspects of environmental surveillance in Germany. However, there is no suggestion that the environmental monitoring applied to the Wismut remediation project in Germany is not in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(4) The recommendations presented in this report are summarised in the 'Main Findings' document that is addressed to the German competent authority through the Permanent Representative of Germany to the European Union.

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

(6) 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

VERIFICATION PROGRAMME

Monday 27/08

a.m.

Dresden, SMUL

Opening Meeting

- Presentation by TREN on Article 35
- Presentations by Wismut, BfS, UBG, SMUL, LfUG
- Agree final programme

p.m.

Radebeul-Wahnsdorf

- Laboratory visit: 1. Landesmessstelle der Staatlichen Umweltbetriebsgesellschaft
- BfS measurement station

Tuesday 28/08

a.m.

Königstein

- Visit locations around Königstein

p.m.

Chemnitz

- Laboratory visit: 2. Landesmessstelle der Staatlichen Umweltbetriebsgesellschaft

Wednesday 29/08

a.m.

Chemnitz

- Wismut GmbH HQ:

Routine and remediation-related-monitoring,

- Long-term monitoring
- Sampling and measurement procedures,
- Wismut GmbH's QA System,
- Data management and archiving,
- Reporting,
- Laboratory Information- and Management System (LIMS).

p.m.

Seelingstädt

- Visit to Wismut Central Laboratory, Seelingstädt

Reust

- Visit to Wismut calibration laboratory Reust (for gamma instruments)
- Visit to Reust Filter Measurement Laboratory

Thursday 30/08

a.m.

Crossen

- Visit to Wismut locations around Crossen

p.m.

Schlema

- Visit to Wismut locations around Schlema including monitoring equipment at 'brown-field' (wieder nutzbare) sites

Friday 31/08

a.m.

Dresden- Felsenkeller

- Underground Low-activity measurement Laboratory

Dresden, SMUL

Meeting with Wismut Regulators (SMUL, UBG, BMU, LfUG, Wismut)

p.m.

Dresden, SMUL

- Closing Meeting

Appendix 2

Verification activities at the Wismut sites of Königstein, Crossen & Schlema

Königstein

Sampling Point ID	Function	location	Notes
k-0001	Controlled discharges of U and Ra-226 to surface waters	Near Water Treatment Plant	Automatic water sampler
k-0002	Discharge point into Pehnabach	Near estuary of Elbe river	Connected to k-0001 by pipe
Deep well k-66033	Seepage (mine flooding water) into deep ground waters	Near administrative buildings at Königstein	Demonstration of deep well sampling technology
k-66036	Seepage (mine flooding water) into deep ground waters	near Königstein Castle	Well for sampling Königstein third aquifer
k-0008	Seepage waters	Water collection basin at base of Schüsselgrund Spoil Heap	Hand sampling,
k-0028	surface water	Elbe – left bank	Hand sampling
WB4 (Ventilation Shaft #4)	Controlled discharges of dust, long-lived alpha (LLA) and Rn from mine shaft ventilation	3 km SW of administrative buildings at Königstein (near Leupoldishain village)	In-situ measurement of Rn concentrations in ventilation air; dust sampling, determination of LLA in the central laboratory,

Crossen

Sampling Point ID	Function	location	Notes
M-039	Controlled discharges of U and Ra-226 to surface waters	Helmsdorf Water Treatment Plant	
M-204	Diffuse seepage to surface waters	Oberrothenbacher Bach	
217.00	Ground level Radon emissions	Oberrothenbach	
215.15	Ra-226 in precipitation	Private house, main street, Crossen village	

Schlema

Sampling Point ID	Function	location	Notes
Wetland 371, m-538	Monitoring of discharges from artificial wetland	Near mine shaft #371	Wetland created for experimental purposes
m3386A	Sampling of near surface (25 m) ground-waters	Near mine shaft #371	Demonstration of sampling and in-situ determination of water parameters
N/A	Disposal site for contaminated solid waste		Example of licensed remediation monitoring
Large mobile air monitoring station (Messcontainer)	*inter alia* Rn-222, dust and LLA from ongoing remediation activities	heap 66/207	
m-555	Discharge from Water Treatment Plant	Schlema Water Treatment Plant	
Mobile air monitoring station	*inter alia* Rn-222 & LLA	heap 66/207	Used particularly for workplace monitoring
N/A	Rn	Spoil heap 38-new	Not yet released after remediation, owing to higher than expected Rn exhalation; No visit to the site, but explanations given from a vantage point at heap 66/207
Overview from Hammerberghalde around the remediation area	Rn and water monitoring	Hammerberghalde	Not yet completely released after remediation, owing to locally higher than expected Rn exhalation; requiring further investigation and countermeasures
m-108X; 511.32	U and Ra-226 in water; Rn-222 plus LLA	Area below the dam of the Borbach Tailings Pond	All seepage water from the Borbach valley passes through here

N/A … not applicable
LLA … long lived alpha

APPENDIX 3

DOCUMENTATION and LINKS

BMU
http://www.bmu.de/allgemein/aktuell/160.php

LfUG
http://www.smul.sachsen.de/de/wu/190.htm

Wismut GmbH
http://www.wismut.de

SMUL
http://www.umwelt.sachsen.de/de/wu/umwelt/1744_11.htm

IMIS
http://www.bfs.de/ion/imis

BfS
http://www.bfs.de/de/bfs

UBG
http://www.smul.sachsen.de/de/wu/organisation/ubg/index.html

Legislation

Federal Legislation

(does not include DDR legislation)

http://www.gesetze-im-internet.de/index.html

Saxon State Legislation On-line

http://www.revosax.sachsen.de/

GDR legislation relating to uranium mining which is still in force can be found on the BfS server

http://www.bfs.de/de/ion/anthropg/fachinfo/gesetz_gl/gesetz_gl.html

APPENDIX 4

List of relevant national and state legislation

List of legislative acts regulating environmental radioactivity monitoring

- *Verordnung über den Schutz vor Schäden durch ionisierende Strahlung (Strahlenschutzverordnung – StrlSchV) vom 20. Juli 2001 (BGBl I S. 1714) http://bundesrecht.juris.de/strlschv_2001/index.html*
- *Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 (GBl. I Nr. 30 S. 342) nebst Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 (GBl. I Nr. 30 S. 348; Ber. GBl. I 1987 Nr. 18 S. 196) – DDR-Recht http://www.bfs.de/ion/anthropg/fachinfo/gesetz_gl/voas_df.pdf*
- *Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei der Verwendung der darin abgelagerten Materialien vom 17. November 1980 (GBl. I Nr. 34 S. 347) – DDR-Recht*
- *Richtlinie zur Emissions- und Immissionsüberwachung bei bergbaulichen Tätigkeiten vom 11.08.1997; Erlass des BMU an die Bundesländer Sachsen, Thüringen und Sachsen-Anhalt vom 27.11.1997*

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

- *Richtlinie zur Emissions- und Immissionsüberwachung bei bergbaulichen Tätigkeiten vom 11.08.1997; Erlass des BMU an die Bundesländer Sachsen, Thüringen und Sachsen-Anhalt vom 27.11.1997*
- *Gesetz zum vorsorgenden Schutz der Bevölkerung gegen Strahlenbelastung (Strahlenschutzvorsorgegesetz – StrVG) vom 19. Dezember 1986 (BGBl. I S. 2610, zuletzt geändert durch Achte Zuständigkeitsanpassungsverordnung vom 25. November 2003, BGBl. I S. 2304, 2308)*
- *Allgemeine Verwaltungsvorschrift zum Integrierten Mess- und Informationssystem zur Überwachung der Radioaktivität in der Umwelt (IMIS) nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) vom 13. Dezember 2006 http://www.bmu.de/files/pdfs/allgemein/application/pdf/avv-imis.pdf*

List of legislative acts establishing the responsibilities of the various actors in this domain

- *Grundgesetz für die Bundesrepublik Deutschland vom 23. Mai 1949 (BGBl. I S. 2863) Artikel 85 – Bundesauftragsverwaltung / Bundesaufsicht*
- *Beschlüsse des Deutschen Bundestages vom 22. Mai 1962 (Drucksache IV/281) und 14. März 1975 (Bundesdrucksache 7/4706 v. 05.02.1976, S 1) zur Berichterstattung über die Umweltradioaktivität*
- Definiton of responsibilities of *Länder* /Saxony (cf. item # 1)

Legislative acts governing NORM applicable to Wismut activities

- *StrlSchV, §§ 97 – 102 and § 118 (5)*