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DIRECTORATE-GENERAL FOR ENERGY

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Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

GERMANY

Routine and emergency radioactivity monitoring arrangements in Berlin

2 - 4 May 2017

Reference: DE 17-02

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES:	Routine and emergency radioactivity monitoring arrangements in Berlin
LOCATIONS:	Berlin, Potsdam
DATES:	2 – 4 May 2017
REFERENCE:	DE 17-02
TEAM MEMBERS:	Mr V. Tanner (team leader) Mr A. Ryan
REPORT DATE:	17 April 2018

SIGNATURES:

V. Tanner A. Ryan

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1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with basic safety standards[1]. Article 35 also gives the European Commission the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The Joint Research Centre Directorate-General provides technical support during the verification visits and in drawing up the reports.

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

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways;
- levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified Germany of its decision to conduct an Article 35 verification in a letter addressed to the German Permanent Representation to the European Union. The German Government subsequently designated the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) to lead the preparations for this visit.

2.2 DOCUMENTS

To assist the verification team in its work, the national authorities supplied an information package in advance[3]. Additional documentation was provided during and after the visit. The information thus provided was used extensively in drawing up the descriptive sections of the report.

2.3 PROGRAMME OF THE VISIT

The Commission and the BMUB discussed and agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006.

The opening meeting included presentations by the verification team and the following entities:

- Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

[1] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (OJ L 159, 29.6.1996, replaced by Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (OJ L 13, 17.1.2014, p. 1).

[2] Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006, pp. 2-5).

[3] Replies to the preliminary information questionnaire addressed to the national competent authority, received on 12 April 2017.

- Federal Office for Radiation Protection (BfS)
- Senate Department for the Environment, Transport and Climate Protection
- Radiation Monitoring Station of the Federal State of Berlin
- Senate Department for Justice, Consumer Protection and Anti-Discrimination
- Senate Department for Health, Long-Term Care and Gender Equality
- Criminal Investigation Department of the Berlin Police, Institute for Criminal Technology
- Berlin Fire Brigade

The verification team pointed to the quality and comprehensiveness of all the presentations and documentation.

The team carried out the verifications in accordance with the programme in Appendix 1. It met the following representatives of the national authorities and other parties involved:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Name	Role
Dr. Johannes Kuhlen	Head of the Division for Radioecology, Environmental Radioactivity Surveillance, Emergency Preparedness and Response
Dr. Reimund Stapel	Desk Officer within the Division for Radioecology, Environmental Radioactivity Surveillance, Emergency Preparedness and Response

Federal Office for Radiation Protection

Name	Role
Mr. Frank Weiler	Head of the Berlin Monitoring Network Node, Section for IMIS Monitoring Tasks
Dr. Werner Preuße	Head of the Section for IMIS Management

Senate Department for the Environment, Transport and Climate Protection

Name	Role
Dr. Heike Kaupp	Head of the Division for Oversight under Atomic Energy Law, Radiation Monitoring Station, Air Quality Monitoring
Dr. Bernd Leps	Head of the Group for Oversight under Atomic Energy Law and Radiation Monitoring Station
Mr. Davood Kavianpour	Desk Officer for the Supreme Radiation Protection Authority

Radiation Monitoring Station of the Federal State of Berlin

Name	Role
Ms. Kathrin Günther	Deputy Head of the Radiation Monitoring Station; Technical Director for Radioactivity in the Environment; Head of the Personal Dosimetry Station
Ms. Martina Kloster	Deputy Technical Director for Radioactivity in the Environment, Laboratory-Based α and β Monitoring
Ms. Constanze Ilchmann	IMIS Federal State Data Centre, Laboratory-Based γ Monitoring; Deputy QM Representative

Senate Department for Justice, Consumer Protection and Anti-Discrimination

Name	Role
Dr. Angelika Bläschke	Head of the Department for Food Monitoring, Veterinary Affairs and Genetic Technology
Dr. Ulf Wilhelm Stodt	Desk Officer within the Department for Food Monitoring, Veterinary Affairs and Genetic Technology

Senate Department for Health, Long Term Care and Gender Equality

Name	Role
Dr. Gudrun Luck-Bertschat	Head of the Working Group for Infection Control and Environmental Health Protection

State Office for Health and Social Affairs Berlin

Name	Role
Dr. Anna Franz	Desk Officer within the Working Group for Water Hygiene and Environmental Health Protection

Helmholtz Centre Berlin for Materials and Energy

Name	Role
Dr. Rolf Hellhammer	Deputy Head of the Staff Department for Radiation Protection

Criminal Investigation Department of the Berlin Police, Institute for Criminal Technology

Name	Role
Dr. Holger Ciglasch	Head of the Department for Hazardous Substances/Analysis of Explosive Substances
Mr. Andreas Hollburg	Deputy Head of the Department for Hazardous Substances/Analysis of Explosive Substances; Division for Environmental Crimes, Data Transmission System

Berlin Fire Brigade

Name	Role
Mr. Constantin Ahrens	Head of the Group for Disaster Response and Incident Prevention
Mr. Peter Draffehn	Senior Expert on Disaster Response, Department for Firefighting, Technical Assistance and Disaster Response
Mr. Hartmut Remus	Senior Expert on CBRN protection, Department for Firefighting, Technical Assistance and Disaster Response

Federal Institute of Hydrology

Name	Role
Mr. Markus Kiefer	Technical Head of the Group for Monitoring Networks of Department G4 Radiology and Water Monitoring
Dr. Gerhard Dersch	Deputy Head of the Department G4

German Meteorological Service

Name	Role
Mr. Michael Mirsch	Assistant Desk Officer for IMIS and Emergency Response

3 LEGISLATIVE PROVISIONS ON THE MONITORING OF RADIOACTIVITY

3.1 INTRODUCTION

The competencies of the Federal States in relation to environmental monitoring in Germany are distinct from the competencies of the Federal Government. Pursuant to Article 73 of the Basic Law, the Federal Government has exclusive legislative power as regards the generation and use of nuclear energy for peaceful purposes. The Act on the peaceful use of nuclear energy and protection against its risks (Atomic Energy Act) is enforced by the Federal States within the framework of federal executive administration pursuant to Article 85 of the Basic Law. The Federal States are therefore responsible for overseeing nuclear facilities and monitoring radioactivity in the environment in connection with these facilities. The Federal Government exercises oversight over the legitimacy and expediency of these activities.

3.2 GENERAL MONITORING

Pursuant to the Precautionary Radiation Protection Act [Strahlenschutzvorsorgegesetz, StrVG], which was adopted in response to the Chernobyl reactor accident, the Federal Government is responsible for the general monitoring of radioactivity in the environment throughout Germany. Findings which emerge from the monitoring of radioactivity in the environment are reported to Parliament and to the public irrespective of competencies[4].

The provisions on the facility-specific and general monitoring of radioactivity in the environment also cover radiological emergencies. They include in particular the provisions of the REI Guidelines on incidents/accidents, and the Integrated Measuring and Information System (IMIS) General Administrative Provisions concerning emergency operation. The Framework Recommendations on disaster response in the area surrounding nuclear facilities contain information on planned monitoring measures in the area surrounding nuclear facilities, particularly with regard to disaster response measures (sheltering, evacuation, iodine prophylaxis).

3.3 MONITORING OF FOOD, FEED AND DRINKING WATER

Food and feed monitoring is regulated in the following legislative and administrative provisions on both facility-specific and general environmental monitoring.

- Programmes for monitoring compliance with EU maximum permissible levels within the framework of general food and feed monitoring are set out in the General Administrative Provisions on the monitoring of compliance with the maximum permissible levels for feedstuffs under Council Regulation (Euratom) No 3954/87[5] [Administrative Provisions on Precautionary Radiation Protection for Feedstuffs; Futtermittel-Strahlenschutzvorsorge-Verwaltungsvorschrift, FMStrVVwV] of 22 June 2000 (Federal Gazette 2000, No 122);
- General Administrative Provisions implementing the monitoring of foodstuffs under Council Regulation (Euratom) No 3954/87 [General Administrative Provisions on Precautionary Radiation Protection and Monitoring of Foodstuffs; AVV-Strahlenschutzvorsorge-Lebensmittelüberwachung-AVV-StrahLe] of 28 June 2000 (Joint Ministerial Gazette 2000, No 25, p. 490)).

[4] Decisions of the German Bundestag of 22 May 1962 (official record IV/281) and 14 March 1975 (Federal Government official record 7/4706 of 5.2.1976, p. 1) on the reporting of radioactivity in the environment, §5(2) of the Precautionary Radiation Protection Act

[5] Council Regulation (Euratom) No 3954/87 of 22 December 1987 laying down maximum permitted levels of radioactive contamination of foodstuffs and of feedingstuffs following a nuclear accident or any other case of radiological emergency (OJ L 371 of 30.12.1987)

The Administrative Provisions on Precautionary Radiation Protection for Feedstuffs and the General Administrative Provisions on Precautionary Radiation Protection and Monitoring of Foodstuffs have remained in force despite the repealing of Regulation (Euratom) No 3945/87 by Council Regulation (Euratom) 2016/52[6].

The monitoring of natural radioactivity in drinking water is regulated by the Third Ordinance Amending the Drinking Water Ordinance of 18 November 2015 (Federal Law Gazette I p. 2076), which entered into force on 26 November 2015. This Ordinance transposes into national legislation the Council Directive 2013/51/Euratom[7].

3.4 ACTS ON RADIOACTIVITY MONITORING

The following acts and administrative provisions regulate radioactivity monitoring in Germany:

- Basic Law for the Federal Republic of Germany of 23 May 1949 (Federal Law Gazette I p. 1) (Federal Law Gazette III 100-1) (Articles 85, 87c – Federal executive administration / federal oversight)
- Act on the peaceful use of nuclear energy and protection against its risks (Atomic Energy Act) in the version promulgated on 15 July 1985 (Federal Law Gazette I p. 1565), most recently amended by Article 3 of the Act of 27 January 2017 (Federal Law Gazette I p. 114)

  http://www.gesetze-im-internet.de/bundesrecht/atg/gesamt.pdf
- Act on the precautionary protection of the public against radiation (Precautionary Radiation Protection Act) of 19 December 1986 (Federal Law Gazette I p. 2610), most recently amended by Article 91 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474)

  http://www.gesetze-im-internet.de/bundesrecht/strvg/gesamt.pdf
- Ordinance on the prevention of the damaging effects of ionising radiation [Radiation Protection Ordinance; Strahlenschutzverordnung, StrlSchV] of 20 July 2001 (Federal Law Gazette I p. 1714; 2002 I p. 1459), most recently amended by Article 6 of the Act of 27 January 2017 (Federal Law Gazette I p. 114)

  https://www.gesetze-im-internet.de/strlschv_2001/BJNR171410001.html
- General Administrative Provisions on the Integrated Monitoring and Information System for the monitoring of radioactivity in the environment (IMIS) under the Precautionary Radiation Protection Act [Allgemeine Verwaltungsvorschrift zum Integrierten Mess- und Informationssystem zur Überwachung der Radioaktivität in der Umwelt (IMIS) nach dem Strahlenschutz-vorsorgegesetz, AVV-IMIS] of 13 December 2006.

  http://www.verwaltungsvorschriften-im- internet.de/bsvwvbund_13122006_RSII5114349.htm
- Guidelines on the emissions and immissions monitoring of nuclear facilities, Circular of the Federal Ministry for the Environment of 7.12.2005 (Joint Ministerial Gazette 2006, No 14-17, p.254)

  http://www.verwaltungsvorschriften-im-internet.de/bsvwvbund_07122005_RSII5156035.htm

[6] Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90 (OJ L 13, 20.1.2016, p. 2)

[7] Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption (OJ L 296, 7.11.2013, p. 12)

- Framework Recommendations on the remote monitoring of nuclear power plants, Circular of the Federal Ministry for the Environment of 12.8.2005 (Joint Ministerial Gazette 2005, No 51, p. 1049)

  http://www.verwaltungsvorschriften-im-internet.de/bsvwvbund_12082005_RSII51703134.htmi

- Instructions for the monitoring of radioactive substances in the environment and external radiation, ISSN 1865-8725

  strahlenschutz/strahlenschutz/radioaktivitaet-in-der-umwelt/messanleitungen/

- Framework Recommendations on disaster response in the area surrounding nuclear facilities, Circular of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety of 21.1.2016 (Federal Gazette AT 04.01.2016 B4)

  http://www.ssk.de/SharedDocs/Beratungsergebnisse_PDF/2015/Rahmenempfehlungen_Katastrophenschutz.pdf?__blob=publicationFile

3.5 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below includes the main international legislation and guidance documents issued by the European Union (EU) and the International Atomic Energy Agency (IAEA), that form the basis for environmental radioactivity monitoring, the radiological surveillance of foodstuffs and the radiological surveillance of radioactive discharges.

The European Union

- The Euratom Treaty (1957)
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018. (OJ L 13 of 17.1.2014)
- Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption (OJ L 296 of 7.11.2013)
- Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole (OJ L191 of 27.7.2000)
- Commission Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation (OJ L36 of 6.1.2004)

International bodies, in particular the International Atomic Energy Agency (IAEA)

- *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna, 2014
- *Clearance of materials resulting from the use of radionuclides in medicine, industry and research*, IAEA-TECDOC-1000, IAEA, Vienna, 1998
- *Generic models for use in assessing the impact of discharges of radioactive substances to the environment*, Safety Reports Series No 19, IAEA, Vienna, 2001
- *Handbook of parameter values for the prediction of radionuclide transfer in temperate environments*, Technical Reports Series No 364, IAEA, Vienna, 1994
- *International basic safety standards for protection against ionizing radiation and for the safety of radiation sources*, Safety Series No 115, IAEA, Vienna, 1996

- *Management of radioactive waste from the use of radionuclides in medicine*, IAEA-TECDOC-1183, IAEA, Vienna, 2000
- *Regulatory control of radioactive discharges to the environment: Safety Guide*, Safety Standards Series No. WS-G-2.3, IAEA, Vienna, 2000

4 BODIES RESPONSIBLE FOR THE MONITORING OF RADIOACTIVITY

4.1 FEDERAL REPUBLIC OF GERMANY

4.1.1 Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, BMUB) is responsible for legislative and regulatory provisions in the fields of radiation protection and precautionary radiation protection and for exercising federal oversight over enforcement of the Atomic Energy Act and the Precautionary Radiation Protection Act.

In radiological emergencies, the BMUB is responsible for large-scale assessments of the situation under the Precautionary Radiation Protection Act.

4.1.2 Federal Office for Radiation Protection

The Federal Office for Radiation Protection [Bundesamt für Strahlenschutz, BfS] is responsible for performing administrative tasks on behalf of the Federal Government in the field of radiation protection, including precautionary radiation protection, and for providing technical and scientific support to the BMUB, in particular when exercising federal oversight.

4.2 FEDERAL STATE OF BERLIN

4.2.1 Administrative structure and competencies

Unlike the non-city federal states, Berlin has a two-tier administrative structure. The Central Administration is made up of the senate departments and their subordinate institutions. It performs all the tasks which are important for Berlin as a whole and which require comprehensive or uniform regulation. The senate departments are headed by Members of the Berlin Federal State Government (the Senate). Each Senator has control over one of the senate departments, which are similar to the ministries in the non-city federal states in terms of their structure and organisation.

The institutions, agencies and authorities which are subordinate to the senate departments work independently but are subject to the relevant department's administrative and technical oversight. For example, the Berlin Fire Brigade [Berliner Feuerwehr, Bln Fw] and the Police President of Berlin [Der Polizeipräsident in Berlin, PolPräs Bln] are subordinate to the Senate Department for Interior Affairs and Sport [Senatsverwaltung für Inneres und Sport, SenInnSport], whereas the Radiation Protection Department of the Federal State Office for Occupational Safety, Health Protection and Technical Safety [Landesamt für Arbeitsschutz, Gesundheitsschutz und technische Sicherheit, LAGetSi] is subordinate to the Senate Department for the Environment, Transport and Climate Protection [Senatsverwaltung für Umwelt, Verkehr und Klimaschutz, SenUVK].

The lower administrative level comprises the twelve district administrations, which are primarily responsible for local affairs in the relevant district. Each district administration consists of a district assembly [Bezirksverordnetenversammlung, BVV] and a district authority.

4.2.2 Organisation of hazard prevention

The principles governing hazard prevention are regulated in the Federal State of Berlin by §§1 to 4 of the General Security and Public Order Act[8]. Pursuant to that act, hazard prevention is the responsibility of the regulatory authorities (senate departments and district authorities; special authorities of the Central Administration with responsibility for regulatory tasks) and the police. This responsibility entails making the relevant preparations to ensure that assistance can be provided and action can be taken in an emergency. The competencies of the regulatory authorities are specified in detail in the Annex to the General Security and Public Order Act, which contains a list of competencies in relation to regulatory tasks. The Berlin Fire Brigade provides assistance with hazard prevention tasks and also helps other authorities and public bodies with enforcement-related tasks. With the exception of the cases covered by §1(1) sentence 2 and §1(3) of the General Security and Public Order Act, the police only acts under its own responsibility in connection with hazard prevention tasks if it does not appear possible that another authority can prevent the hazard or can do so in good time.

Pursuant to the Berlin Disaster Response Act[9], the disaster response authorities are the regulatory authorities and the police. The disaster response authorities must take any preparatory measures necessary to combat disasters.

These legislative provisions ultimately mean that the specialist departments in Berlin (unlike in all the other Federal States) have primary responsibility for emergency response planning. For example, the Senate Department for the Environment, Transport and Climate Protection has primary responsibility both for planning the Federal State's response to incidents in nuclear facilities outside Berlin and for the disaster response plan for the area surrounding the research reactor BER II.

4.2.3 Monitoring Station for Radioactivity in the Environment

The body responsible for monitoring radioactivity in the environment in the Federal State of Berlin pursuant to §3 of the Precautionary Radiation Protection Act is the Monitoring Station for Radioactivity in the Environment, which operates within the Berlin Radiation Monitoring Station (SMS). It is organised and equipped in such a way that it can increase its throughput of samples many times over if the BMUB imposes an emergency monitoring programme. An organisational chart can be seen in Appendix 3.

The Monitoring Station for Radioactivity in the Environment has been appointed by the supervisory authority under atomic energy law as an independent Monitoring Station for monitoring the area surrounding the research reactor BER II pursuant to the REI Guidelines[10]. It also carries out official monitoring in certain other cases for the purpose of calculating the level of radioactivity in samples, on contaminated land, for post-closure care, etc.

[8] Allgemeines Sicherheits-und Ordnungsgesetz, ASOG

[9] Berliner Katastrophenschutzgesetz, BlnKatSG

[10] Richtlinie zur Emissions-und Immissionsüberwachung kerntechnischer Anlagen, Guidelines on the emissions and immissions monitoring of nuclear facilities

5 PROGRAMMES FOR MONITORING RADIOACTIVITY IN BERLIN

5.1 MONITORING BY THE GERMAN FEDERAL AUTHORITIES

5.1.1 Introduction

Pursuant to the Precautionary Radiation Protection Act, radioactivity in the environment must be monitored in order to protect the public. The monitoring tasks are divided between the Federal Government and the Federal States.

§4 'Federal Government information system' of the Precautionary Radiation Protection Act establishes the IMIS System for the monitoring of radioactivity in the environment. The system is operated by the Central Federal Agency for the Surveillance of Radioactivity in the Environment [Zentralstelle des Bundes, ZdB] within the BfS. The tasks relating to the monitoring of radioactivity in the environment which are performed by the Federal Government and Federal State authorities are consolidated within the IMIS; this system also makes it possible for the Federal States to discharge their reporting obligations towards the Federal Government under the REI Guidelines.

The General Administrative Provisions on IMIS for the monitoring of radioactivity in the environment under the Precautionary Radiation Protection Act outline the monitoring programmes for normal operation (routine monitoring programme) and emergency operation (emergency monitoring programme). The routine monitoring programme meets the EU requirements for the 'sparse network' and 'dense network' (Article 36 Euratom, Commission Recommendation 2000/473/Euratom). The purpose of emergency operation is to allow an event with potential radiological consequences to be managed; it essentially involves stepping up of the routine monitoring programme for a limited time and in some cases over a limited geographical area.

The Federal Government's monitoring tasks include large-scale measurements of levels of radioactivity in air, in precipitation, in federal waterways and in the North Sea and Baltic Sea outside federal waterways, in marine organisms and on the soil surface, as well as large-scale measurements of the ambient gamma dose rate. These monitoring tasks are for the most part performed using the following monitoring networks:

- ambient gamma dose rate monitoring network of the BfS
- monitoring networks for air and precipitation of the German Meteorological Service [Deutscher Wetterdienst, DWD]
- early warning network for monitoring federal waterways of the Federal Institute of Hydrology [Bundesanstalt für Gewässerkunde, BfG]
- monitoring network for the North Sea and Baltic Sea of the Federal Maritime and Hydrographic Agency [Bundesamt für Seeschifffahrt und Hydrographie, BSH]

5.1.2 Monitoring tasks and requirements for the routine monitoring programme

The monitoring tasks of the Federal States include the measurement of levels of radioactivity in foodstuffs, feedstuffs, drinking water, groundwater, soil, plants, waste water, sludge and waste. Around 10 000 measurements are carried out throughout Germany each year for this purpose under the routine monitoring programme.

Where gamma spectrometric analysis is necessary, the samples must be analysed for at least the following nuclides and the results documented: ^{40}K, ^{60}Co, ^{103}Ru, ^{131}I, ^{134}Cs, ^{137}Cs and ^{144}Ce. Different requirements concerning compliance with the detection limits for ^{60}Co apply for each environmental sector.

When analysing alpha emitters, this applies mutatis mutandis to the nuclides ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239/240}$Pu and ^{241}Am, and when analysing beta emitters to ^{3}H, ^{89}Sr and ^{90}Sr, unless otherwise specified under the individual programmes.

When recording monitoring outcomes either the activity at the time when the sample was taken or the mean for a collection period must be specified (or the calculated detection limit). As a general rule, measurements must be stated with a standard measurement uncertainty (1-sigma) as a percentage.

Reporting is unnecessary if the difference between the time of sampling and the time of measuring is over six times the half-life, because the measured value is then less than 2 % of the value at reference time and the uncertainty of the calculated value at reference time is likely to exceed the value.

5.1.3 Monitoring tasks and requirements for the emergency monitoring programme

Emergency operation is triggered for events with potentially significant radiological consequences in order to detect large scale radioactive contamination in the environment, to obtain a rapid overview of the radiological situation, to estimate radiation exposure, and to obtain a basis for recommendations and measures to reduce radiation exposure. The IMIS General Administrative Provisions refer to examples of the type of event which may result in the release of radioactive substances affecting multiple Federal States and which may require emergency operation.

In order to allow a differentiated approach, a distinction is made between the three phases involved in the dispersion of radioactive substances. Table I provides an overview of the three phases together with their differing monitoring goals and the way these are implemented within the monitoring networks and environmental sectors.

The data are used for decision-making purposes when adopting recommendations and measures, and feed into estimates of the radiation exposure received by the public affected.

Table I. Three phases of dispersion of radioactive substances

	Phase 1	Phase 2	Phase 3
When:	before and during the dispersion of radioactive substances	immediately after dispersion (ground deposition completed)	after dispersion, when the initial contamination has reduced significantly
Aim of measurements:	- which areas are affected? - level of external radiation exposure? - radionuclide composition?	- detailed information on the areas, the level of contamination and radionuclide composition - locally representative situation report for the various environmental sectors - small-scale inhomogeneities - overview of agricultural products	- environmental sectors in which increased activity concentrations may arise - further development of activity concentrations in the relevant environmental sectors - increase in the number of measurements in regions where long-term measures may be necessary

	Phase 1	Phase 2	Phase 3
Monitoring networks involved, environmental sectors investigated:	- Federal Office for Radiation Protection: ambient gamma dose rate every 10 minutes (plus net values) - German Meteorological Service: nuclide-specific activity concentration in the air every two hours, and in precipitation and dispersion calculations - Federal Institute of Hydrology: total gamma activity concentration in federal waterways, every hour	- continued operation of the monitoring networks of the Federal Office for Radiation Protection, German Meteorological Service and Federal Institute of Hydrology (see Stage 1) - use of mobile systems (vehicles, helicopter; ambient dose rate, in-situ gamma spectrometry) - targeted sampling in the areas affected (in particular representative media and harvest-ready products) - measurement of samples by the monitoring stations of the Federal States - situational adjustments by means of localised increases in sampling or repeated sampling for relevant environmental sectors	- furthermore increased in sampling/measurements depending on the region affected and relevant environmental sectors - otherwise at least in line with the requirements of the routine monitoring programme

5.1.4 Data recording and transmission

All the measurement data are collated in the IMIS. The Federal Government Central Agency is responsible for compiling, preparing, documenting and evaluating the data collected under the Precautionary Radiation Protection Act. The IMIS is also used to record the findings from facility-specific monitoring pursuant to the REI Guidelines and to meet the reporting requirements under these Guidelines (electronic reporting archive in IMIS for the REI Guidelines). This does not affect the differing statutory basis for these two monitoring programmes. The flow of data between the institutions involved in the IMIS can be seen in Figure 1.

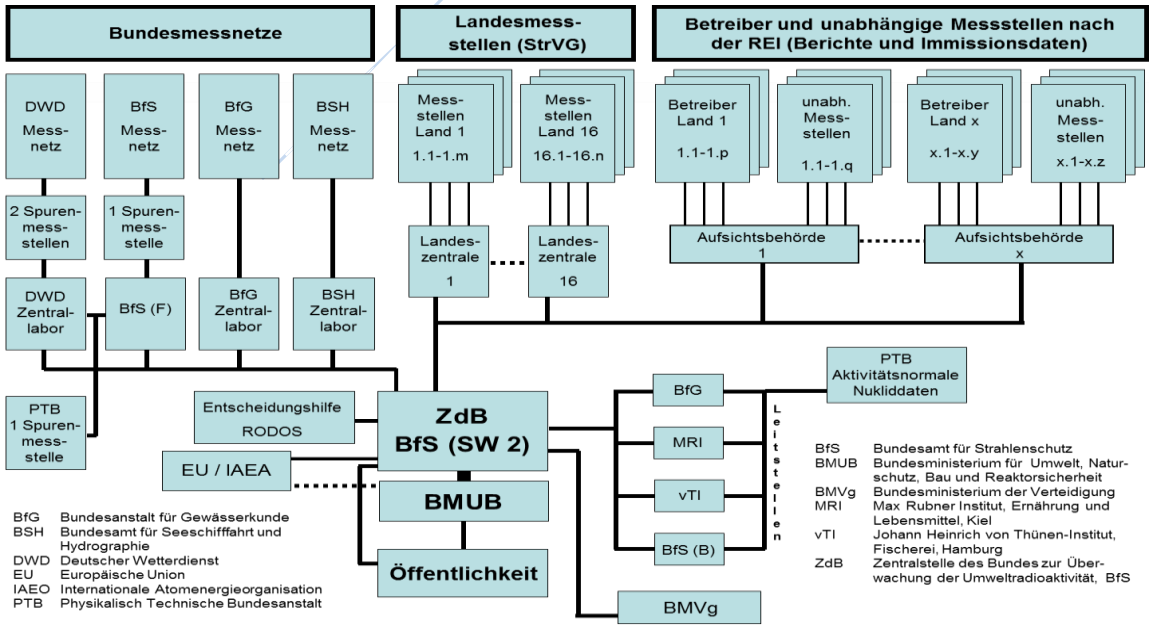

Figure 1: Flow of data between the institutions involved in the IMIS (English translation below)

DE	EN
Bundesmessnetze	*Federal monitoring networks*
Landesmessstellen (StrVG)	*Federal State monitoring stations (under the Precautionary Radiation Protection Act)*
Betreiber und unabhängige Messstellen nach der REI (Berichte und Immissionsdaten)	*Operators and independent monitoring stations under the REI Guidelines (reports and immissions data)*
DWD Messnetz	*DWD Monitoring network*
BfS Messnetz	*BfS Monitoring network*
BfG Messnetz	*BfG Monitoring network*
BSH Messnetz	*BSH Monitoring network*
Messstellen Land 1 1.1-1.m	*Monitoring laboratories Federal State 1 1.1-1.m*
Messstellen Land 16 16.1-16.n	*Monitoring laboratories Federal State 16 16.1-16.n*
Betreiber Land 1 1.1-1.p	*Operator Federal State 1 1.1-1.p*
Unabh. Messstellen 1.1-1.q	*Independent Laboratories 1.1-1.q*
Betreiber Land x x.1-x.y	*Operator Federal State x x.1-x.y*
Unabh. Messstellen x.1-x.z	*Independent Laboratories x.1-x.z*
2 Spurenmesstellen	*2 trace measurement laboratories*
1 Spurenmessstelle	*1 trace measurement laboratory*
DWD-Zentrallabor	*DWD Central Laboratory*
BfS (F)	*BfS (Freiburg)*
BfG Zentrallabor	*BfG Central Laboratory*
BSH Zentrallabor	*BSH Central Laboratory*
Landeszentrale 1	*Federal Land headquarters 1*
Landeszentrale 16	*Federal Land headquarters 16*
Aufsichtsbehörde 1	*Supervisory authority 1*
Aufsichtsbehörde x	*Supervisory authority x*
PTB 1 Spurenmessstelle	*PTB 1 trace measurement laboratory*
Entscheidungshilfe RODOS	*RODOS decision support system*
ZdB BfS (SW2, Strahlenschutz und Umwelt 2)	*ZdB BfS (SW2 Radiation Protection and Environment , dept. 2)*
Öffentlichkeit	*Public*
MRI	*MRI*
BfS (B)	*BfS (Berlin)*
BMVg	*BMVg*
PTB Aktivitätsnormale Nukliddaten	*PTB Activity standards Nuclide data*
BfG Bundesanstalt für Gewässerkunde	*BfG Federal Institute of Hydrology*
BSH Bundesamt für Seeschifffahrt und Hydrographie	*BSH Federal Maritime and Hydrographic Agency*
DWD Deutscher Wetterdienst	*DWD German Meteorological Service*
EU Europäische Union	*EU European Union*
IAEO Internationale Atomenergieorganisation	*IAEA International Atomic Energy Agency*
Leitstellen	*Federal coordinating offices*
PTB Physikalisch Technische Bundesanstalt	*PTB National Metrology Institute*
BfS Bundesamt für Strahlenschutz	*BfS Federal Office for Radiation Protection*
BMUB Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit	*BMUB Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety*
BMVg Bundesministerium der Verteidigung	*BMVg Federal Ministry of Defence*
MRI Max Rubner Institut, Ernährung und Lebensmittel, Kiel	*MRI Max Rubner Institute, Federal Research Institute of Nutrition and Food, Kiel*
vTI Johann Heinrich von Thünen-Institut, Fischerei, Hamburg	*vTI Johann Heinrich von Thünen Institute, Institute of Fisheries, Ecology, Hamburg*
ZdB Zentralstelle des Bundes zur Überwachung der Umweltradioaktivität, BfS	*ZDB Central Federal Agency for the Surveillance of Radioactivity in the Environment*

5.1.5 Quality assurance

The federal coordinating offices are responsible for developing and specifying any sampling, analysis, monitoring and calculation procedures and for performing comparative measurements and comparative analyses. These tasks are performed by the authorities presented in Table II.

Table II. Task distribution of authorities

Coordinating office	Areas covered
Federal Institute of Hydrology	Surface waters, suspended matter and sediment in inland waters
Federal Maritime and Hydrographic Agency (BSH)	Seawater, marine suspended matter and sediment (North Sea and Baltic Sea)
Max Rubner Institute, Federal Research Institute for Nutrition and Food [Max Rubner Institut, MRI]	Soil, vegetation, feedstuffs and foodstuffs of plant and animal origin
Johann Heinrich von Thünen Institute, Institute of Fisheries Ecology [Johann Heinrich von Thünen-Institut, vTI]	Fish and fisheries products, crustaceans, shellfish, aquatic plants
German Meteorological Service [Deutscher Wetterdienst DWD]	Air and precipitation
Federal Office for Radiation Protection (BfS)	Drinking water, groundwater, waste water, sludge, waste and waste water from nuclear facilities Pharmaceutical products and their precursors and consumer goods Exhaust air from nuclear facilities Ambient gamma dose rate Nuclide-specific In-situ-measurement

The following quality assurance measures are taken in connection with IMIS:

- Country-wide uniform procedures for sampling, sample preparation, measurement and the documentation of monitoring outcomes, specified in instructions (produced and updated by the coordinating bodies of the Federal Government) which apply throughout the country and which give guidance for all parties involved.
- Quality assurance of measurements
    - functional check of monitoring systems
    - verification of calibration
    - background measurement
    - interlaboratory testing (= comparative analyses) organised by the coordinating bodies
    - comparative measurements against activity standards provided by the National Metrology Institute
- Automatic testing of the IT system during manual data input or data imports, e.g. whether mandatory fields have been completed, whether consistency rules are met (e.g. time difference between sampling and measurement), whether compliance has been achieved with the prescribed detection limit for ^{60}Co, etc.
- Plausibility tests for measurements in IMIS at 4 levels:
    1. producer/transmitter of the data
    2. competent monitoring network/Federal State (as a general rule, set automatically according to time slice)

3. synoptically according to environmental sector (coordinating bodies)
4. approval by the Federal Ministry for the Environment (as a general rule, set automatically according to time slice)

The principle of dual control is guaranteed by the mandatory checks which must be carried out by the monitoring station and the coordinating office or the supervisory authority.

5.1.6 Monitoring of ambient gamma dose rate

Within the framework of the IMIS, the BfS operates a comprehensive country-wide monitoring network of approximately 1 800 sensors to monitor the ambient gamma dose rate. Figure 2 shows the location of the monitoring stations within the ambient gamma dose rate monitoring network in Berlin and in the surrounding area. There are seven ambient dose rate monitoring stations within the borders of the Federal State of Berlin. There are an additional 15 ambient dose rate monitoring stations in the immediate vicinity of Berlin (up to 20 km outside its borders, in the Federal State of Brandenburg).

The sensors used in the ambient dose rate monitoring network do not incorporate rain sensors. BfS obtains precipitation information from the DWD's radar data, which is stored in the BfS database for every sensor location.

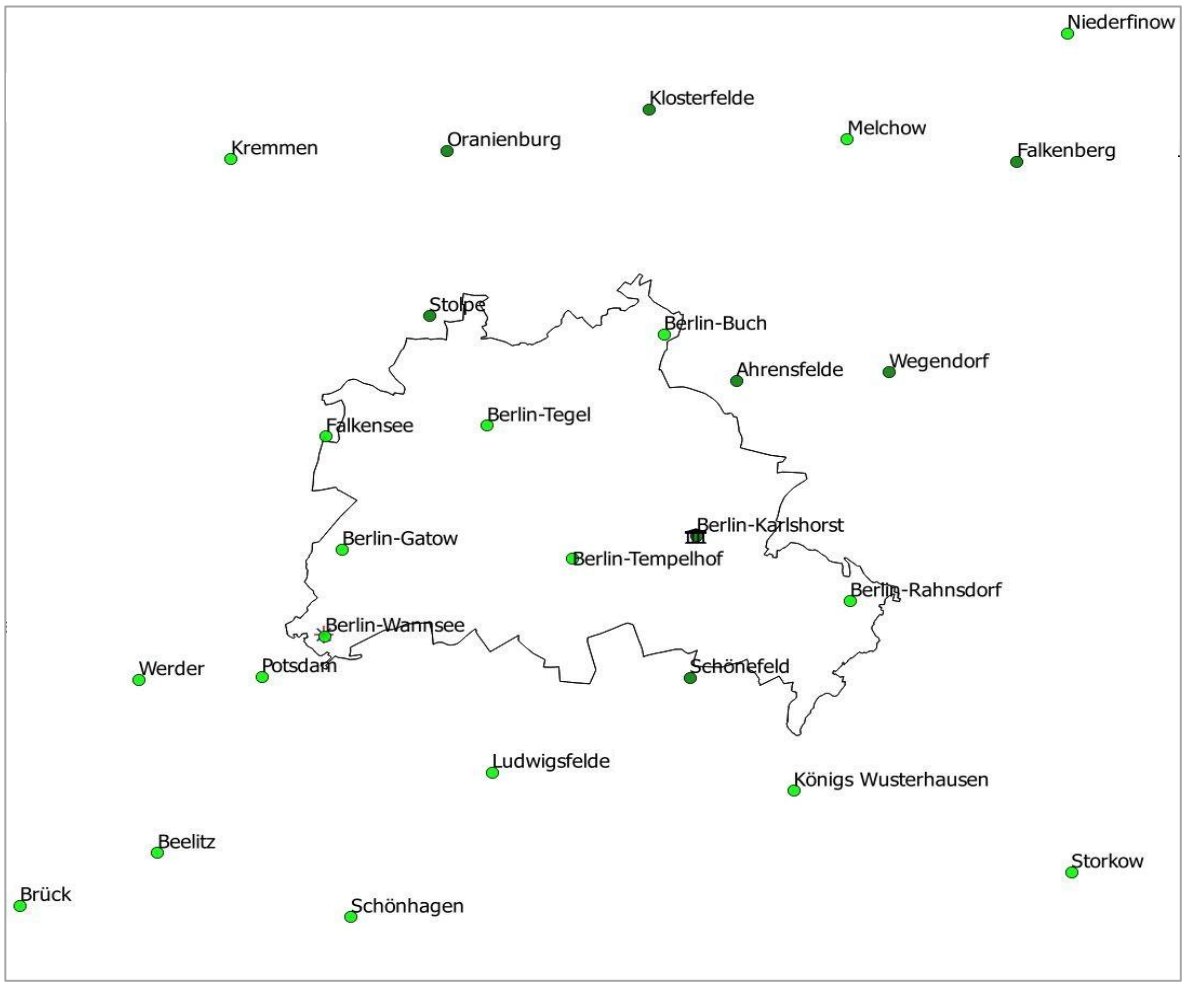

Figure 2. IMIS ambient gamma dose rate monitoring network in Berlin and the surrounding area

5.1.7 Monitoring of air and precipitation

The DWD does not operate its own monitoring station for air and precipitation in Berlin. A station for monitoring air and precipitation is located in Potsdam, a few kilometres to the south-west of Berlin in

the Federal State of Brandenburg. An additional six DWD stations are located within a radius of approximately 100 km in the Federal States of Brandenburg and Saxony-Anhalt (Figure 3 and table III).

Table III. DWD stations in the Berlin area

Measurements in the air (online and laboratory measurements)	Measurement of precipitation and radioactivity in precipitation
• γ spectrometry of aerosols (filter measurements) • γ spectrometry of gaseous iodine (elementary, organically bound) • artificial ß (aerosols) • $^{89}Sr/^{90}Sr$ (aerosols) • artificial α (aerosols) • α spectrometry (aerosols) • sampling of radioactive noble gases ^{85}Kr and ^{133}Xe	• γ spectrometry • total ß • ^{3}H • $^{89}Sr/^{90}Sr$ measurement • α spectrometry

Figure 3. Location of DWD monitoring stations close to Berlin area

In addition to the continuous monitoring of air activity concentrations by the DWD, dust samplers with an air throughput of up to 1 000 m^3/h (high volume samplers) are operated in Berlin at the Potsdam monitoring station. The Potsdam station is one of four German monitoring stations within the EU's sparse network. Weekly samples are taken on a routine basis, but the sampling cycle can be reduced to one day in special situations (e.g. following the Fukushima reactor disaster). The exposed filters are initially subjected to gamma spectrometric analysis at the Potsdam office of the DWD. For weekly samples, the detection limit achieved is approximately 0.1 µBq/m³ for ^{60}Co. The filters are sent to the DWD headquarters in Offenbach and, after radiochemical preparation, analysed there for $^{89/90}Sr$, plutonium, americium and uranium. A collector for gaseous iodine is also operated on a weekly cycle in Potsdam. The detection limit for gaseous ^{131}I is typically around 1 mBq/m³.

Monthly precipitation samples are also taken, evaporated, subjected to gamma spectrometric analysis and sent to Offenbach and, after radiochemical preparation, analysed there for $^{89/90}Sr$, plutonium, uranium, americium and tritium.

The German Meteorological Service's trace measurement programme is supplemented by weekly sampling of the radioactive noble gases krypton and xenon at the Offenbach, Potsdam and Trier stations. After preparation at the BfS noble gas laboratory in Freiburg, the samples are analysed for ^{85}Kr content and total content of radioactive xenon (^{133}Xe) using integral beta measurement in a

proportional counter. The detection limit for ^{133}Xe for this measurement procedure is approximately 1 mBq/m³. A second sample from Offenbach is measured by the DWD itself.

5.1.8 Monitoring of water

The Federal Government is responsible for monitoring water, suspended matter and sediments. Together with the Federal Government's Waterways and Shipping Administration, the Federal Institute of Hydrology operates monitoring stations in Berlin and in the surrounding Federal State of Brandenburg on watercourses which affect Berlin, including the river Spree (in Berlin and approximately 30 km to the east) and the river Havel (approximately 40 km to the north and 20 km to the west). Total γ activity is measured online (hourly values).

Figure 4 shows the Federal Institute of Hydrology online monitoring stations in Berlin and in the surrounding area. Nuclide-specific data are obtained at these stations. Laboratory tests are carried out on samples of water, suspended matter and sediment as follows:

- γ spectrometry (water, suspended matter, sediment)
- ^{3}H, $^{89}Sr/^{90}Sr$ (water)
- total α (water)
- α spectrometry (water), if total α activity concentration > 0.5 Bq/l

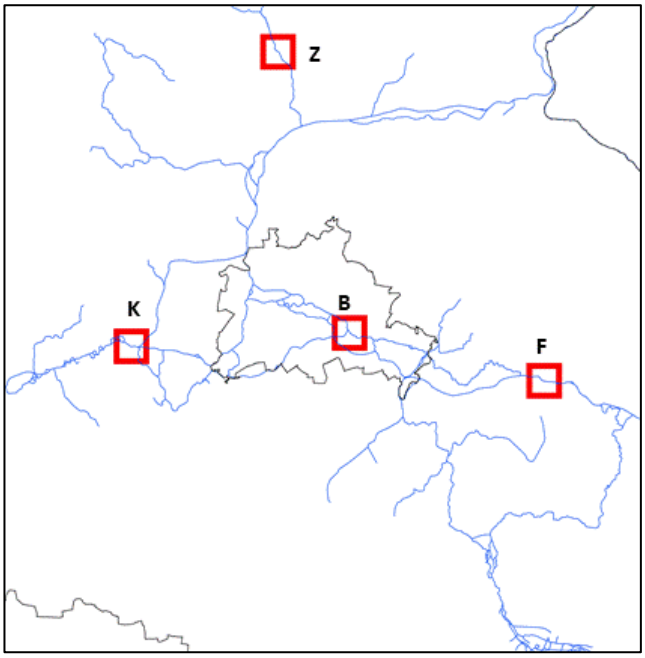

Figure 4. ***Location of the Federal Institute of Hydrology online monitoring stations in Berlin and the surrounding areas (Spree: B (Berlin), F (Fürstenwalde), Havel: K (Ketzin), Z (Zehdenick))***

5.1.9 Monitoring of soil surface

Within the framework of the IMIS, the Federal Government operates six monitoring vehicles for nuclide-specific in-situ measurements. One of these vehicles is stationed in Berlin. The Federal State of Berlin also operates another monitoring vehicle on behalf of the Federal Government, and the Berlin-Brandenburg Federal State Laboratory operates two such vehicles. Under the routine monitoring programme, priority is given to measurements at the ambient gamma dose rate monitoring network locations in order to obtain reference values for ground surface activity. Each sensor is visited once every three years by the BfS.

The DWD has installed a stationary in-situ monitoring device for soil contamination intended for emergency deployment in Potsdam.

5.2 Monitoring by the Federal State of Berlin

5.2.1 Monitoring programme under the Precautionary Radiation Protection Act

One of the goals of the Precautionary Radiation Protection Act is to ensure comprehensive monitoring of radioactivity in the environment. It also allows state bodies to order appropriate measures to minimise the impacts of radiological events. The relevant tasks of the Federal Government and of the Federal States are clearly delineated. On the basis of this delineation of tasks, the Federal State of Berlin is responsible for the majority of the tests needed to monitor radioactivity in the environment. These tests are performed by the Berlin Radiation Monitoring Station, which carries out around 500 measurements each year for this purpose during normal operation.

5.2.2 Monitoring programme under the REI Guidelines

The REI Guidelines lay down requirements for emissions monitoring by operators and immissions monitoring by operators and independent monitoring stations acting on behalf of the competent authority under the atomic energy law. They also lay down requirements concerning the identification of location-specific dispersion conditions and the emissions monitoring of facilities or activities which are subject to authorisation or planning permission pursuant to §§6, 7, 9 and 9b of the Atomic Energy Act. This includes not only nuclear power plants but also research reactors such as the BER II operated at the Helmholtz Centre in Berlin.

The operator programme and the monitoring programme of the independent monitoring station under the REI Guidelines make it possible to assess the public exposure to radiation as a result of discharges of radioactive substances, ensuring that compliance with the maximum permitted releases and dose limits can be verified. The tasks defined in the REI Guidelines are performed by the operator of the BER II and by the Berlin Radiation Monitoring Station, which is an independent body commissioned by the supervisory authority.

As part of the routine monitoring programme for emissions monitoring under the REI Guidelines, approximately 120 measurements are carried out in Berlin each year in the area surrounding the research reactor. The scope of the measurements covers air, precipitation, soil, meadow vegetation, foodstuffs of plant origin, drinking water, surface waters and fish. The samples are evaluated in the operator's laboratory or in the laboratory of the Berlin Radiation Monitoring Station, and the results are transferred to the IMIS.

The Berlin Radiation Monitoring Station submits quarterly and annual reports on the outcomes of the measurements which have been carried out. These are verified by external experts from ESN (ESN Sicherheit und Zertifizierung GmbH) on the basis of the following criteria:

- checks for completeness,
- checks for outlier measurements in the quarterly reports,
- checks to ascertain the coherence of the evaluations, in particular as regards the comments on outlier measurements in the annual report.

The reports are uploaded to the IMIS system. Final checks are carried out by Federal Government agencies (BMUB and BfS), after which approval is granted and all IMIS-authorised bodies can access the reports.

5.2.3 Reactor remote monitoring system of the Federal State of Berlin

In the extremely unlikely event that a nuclear incident were to occur, access to up-to-date, accurate and comprehensive information on facility parameters and the amount of radioactivity released would be of vital importance. Monitoring systems have been put in place to record facility-specific data and environmental radioactivity values for German nuclear power plants [nuclear reactor remote monitoring; Kernreaktor-Fernüberwachung, KFÜ]. A reactor remote monitoring system

[Reaktorfernüberwachungssystem, RFÜ] along similar lines has been put in place also for the BER II research reactor.

5.2.4 Monitoring of gamma dose rate in the area surrounding the research reactor BER II

A monitoring network of sensors for calculating the ambient gamma dose rate has been set up in the area surrounding the research reactor. It operates in a similar way to the IMIS ambient dose rate system of the BfS. It is however a denser network, intended primarily for the monitoring of any emissions caused by the research reactor. The sensors operate on the basis of a separate transmission system incorporated into the reactor remote monitoring system.

The ambient gamma dose in the area surrounding the BER II is calculated by the Berlin Radiation Monitoring Station as an annual dose using the measurements taken at their premises using a phosphate glass dosimeter (radiophotoluminescence dosimeter, RPLD)(Figure 5).

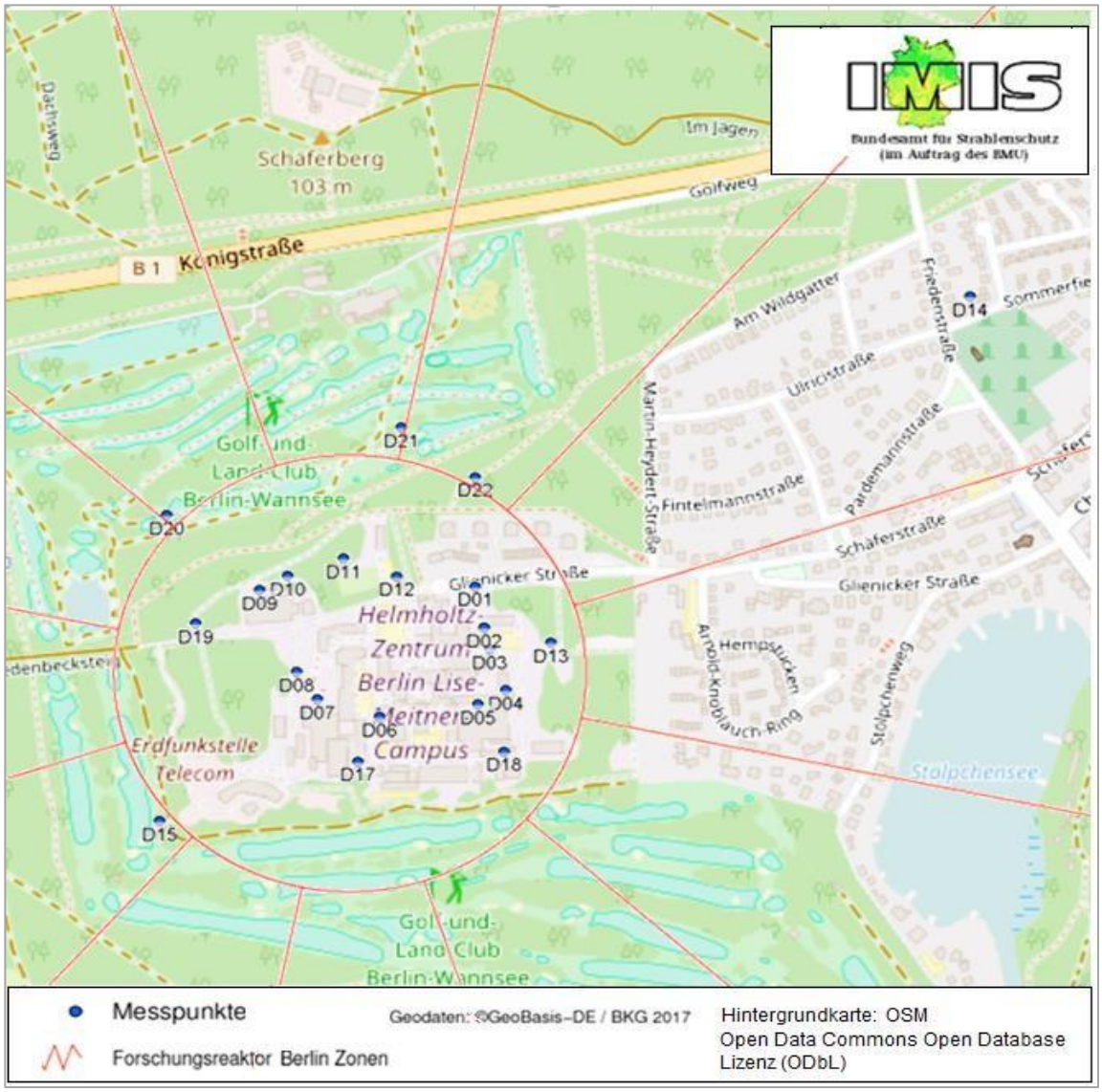

Figure 5. RPLD locations of the Berlin Radiation Monitoring Station at the Helmholtz Centre Berlin (English translation below)

DE	EN
Messpunkte	*Measurement points*
Forschungsreaktor Berlin Zonen	*Berlin research reactor zones*
Geodaten: ©GeoBasis-DE / BKG 2017	*Geodata: ©GeoBasis-DE / Federal Agency for Cartography and Geodesy [Bundesamt für*

DE	EN
	Kartographie und Geodäsie, BKG] 2017
Hintergrundkarte: OSM	*Background map: Open Street Map*
Open Data Commons Open Database Lizenz (OdbL)	*Open Data Commons Open Database licence (OdbL)*

The ambient gamma dosimeters are evaluated on an annual basis. In order to do so, the dosimeters are replaced at the monitoring locations by employees of the Berlin Radiation Monitoring Station and taken for analysis to the evaluation facilities of the Helmholtz Centre in Munich. Analyses are based on the statutory measured variable for local doses as an ambient dose equivalent ($H^*(10)$). The monitoring outcomes are then recorded by the Berlin Radiation Monitoring Station, after which they undergo plausibility testing and are transferred to the IMIS.

The operator also monitors the local dose using a similar number of thermoluminescence dosimeters (TLD). The TLD locations can be seen on Figure 6.

5.3 MONITORING OF RADIOACTIVITY IN AIR

Under the Precautionary Radiation Protection Act, the DWD is responsible for monitoring airborne radioactivity. Additional monitoring in the Federal State of Berlin is carried out by the operator of the research reactor under the REI Guidelines; this is checked by the Berlin Radiation Monitoring Station. The Berlin Radiation Monitoring Station also carries out monitoring at its office on a continuous basis independently of the monitoring programmes, and has mobile monitoring devices which can be used if necessary.

5.3.1 Stationary air monitoring

Two monitoring stations for radioactive aerosols have been set up close to the research reactor (Figure 6). The two graduated filter systems of the type BAI 9100D (at monitoring station MS2) or LB/BAI 9100D (at monitoring station MS4), both manufactured by Berthold, have a filter belt system which conveys air to a filter belt made of glass fibre. The air flows are 25 m^3/h (MS2) and 20 m^3/h (MS4). A filter area of 25 cm^2 (MS2) or 27.5 cm^2 (MS4) is covered with particles. The total beta activity is measured immediately using a scintillation counter. The measured variables are processed using a data logger. All data are forwarded to the reactor remote monitoring system. The monitoring systems have automatic surveillance functions, which report e.g. cracks in the filter belt, the end of a filter belt, malfunctioning of the blower or the crossing of pre-alarm and alarm thresholds.

In addition to instantaneous monitoring, delayed monitoring of the filter belt is carried out after five days. This makes it possible to distinguish between natural and short-lived sources of radiation and artificial sources of radiation.

The Berlin Radiation Monitoring Station (as an independent monitoring station) receives the collected and halved air filters from the monitoring stations MS2 and MS4 at the end of each quarter. The suspended matter filters are subjected to gamma spectrometric analysis.

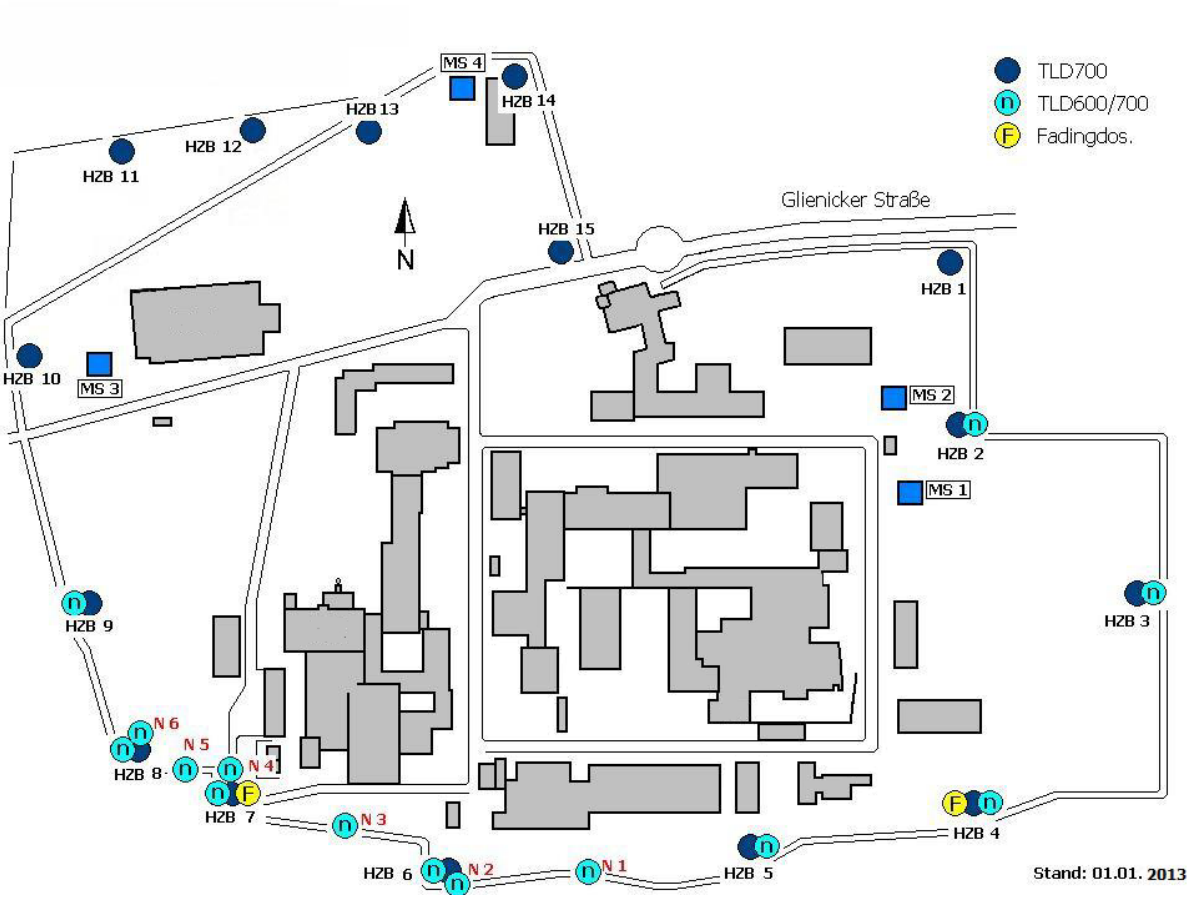

Figure 6. Air monitoring stations (MS2, MS4) and TLDs of the operator on the grounds of the Helmholtz Centre in Berlin

The Berlin Radiation Monitoring Station operates its own air sampler (TracerLab MDS-280/257) independently of the IMIS and REI monitoring programmes, as a reference for monitoring at the Helmholtz Centre. The device continuously draws in ambient air (samples taken above the roof of the annex to Rubensstr. 111), and particles are deposited on a large filter. The routine sampling cycle of seven days can be shortened as necessary in the event of an emergency. Quartz microfibre discs (grade T 293), diameter 257mm by Munktell (or comparable) are used as filters. The exposed filters are arranged in an appropriate geometry and subjected to gamma spectrometric analysis. The following nuclides are reported on a routine basis: ^{7}Be, ^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs, ^{144}Ce. It was possible to use this air sampler to prove the presence of radioactive isotopes in the air after the Fukushima accident.

5.3.2 Mobile air monitoring

In the event of an emergency, the Berlin Radiation Monitoring Station can use a mobile air sampler of the type MAB TFIA-4 (designed for a voltage of 12-24V and an air flow of 3-5 m³/h) to expose aerosol filters and the activated carbon cartridge arranged behind them, and then analyse them using gamma spectroscopy. Round filters with a diameter of 10 cm of the type MN 85/90 BF manufactured by Macherey und Nagel are used for this purpose.

As part of the drill-based monitoring programme under the REI Guidelines for incidents/accidents, samples are taken every six months at three or four monitoring locations, in line with the disaster response plan and then subjected to gamma spectrometric analysis in the laboratory.

5.3.3 Atmospheric deposition monitoring

According to the Precautionary Radiation Protection Act, the DWD is responsible for monitoring precipitation. As an independent monitoring station under the REI Guidelines, the Berlin Radiation

Monitoring Station operates a precipitation (wet deposition) collector (manufactured by Walther & Partner) within the grounds of Rubensstraße 111 (Figure 7). It consists of a heated cupboard (heat output 900-2000 W, with thermostat) and a funnel with a collecting surface of 1 m². The sampler opens automatically when there is precipitation. Below the funnel is a 50-litre collecting tray holding a 10-litre container. Samples are taken every working day if precipitation has occurred, and the volume of precipitation is calculated. The samples are gradually vaporised and combined into monthly samples. They are then subjected to gamma spectrometric analysis. Evaluations are carried out on the basis of the current National Metrology Institute nuclide library. The precipitation collector undergoes visual inspections and is cleaned at least once a month. Additional cleaning is carried out if necessary.

Figure 7. SMS atmospheric deposition sampler

Deposition measurements under the REI Guidelines are carried out by the operator of the research reactor using a similar sampling device and are monitored by the Berlin Radiation Monitoring Station.

5.4 MONITORING OF RADIOACTIVITY IN WATER

While the Federal Government monitors radioactivity in federal waterways and in the North Sea and the Baltic Sea, the Federal State of Berlin is responsible for calculating the level of radioactivity in drinking water, groundwater and surface waters, which are not federal waterways.

5.4.1 Surface waters

Surface waters are sampled at six locations under the IMIS monitoring programme. These include five sampling points at different lakes and one on the river Spree. All of the sampling locations are shown in Figure 8.

A total of seven sampling points have been established for the monitoring programme for incidents under the REI Guidelines. These are located in the area surrounding the research reactor BER II. Their locations can be seen in Figure 9.

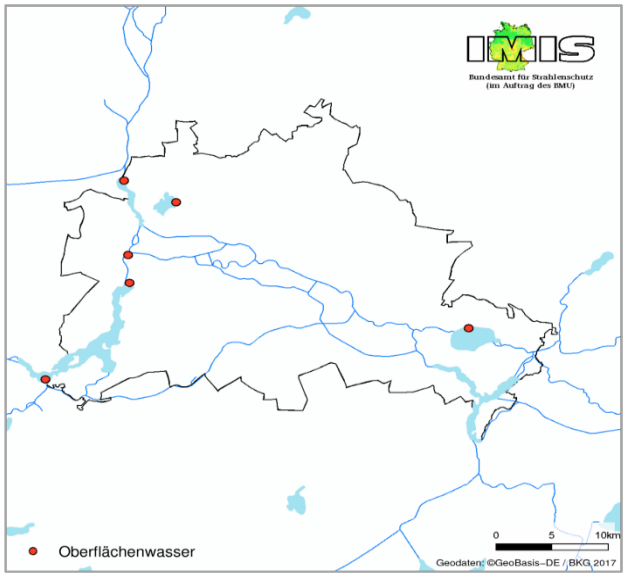

Figure 8. Sampling locations for surface waters in Berlin (IMIS)

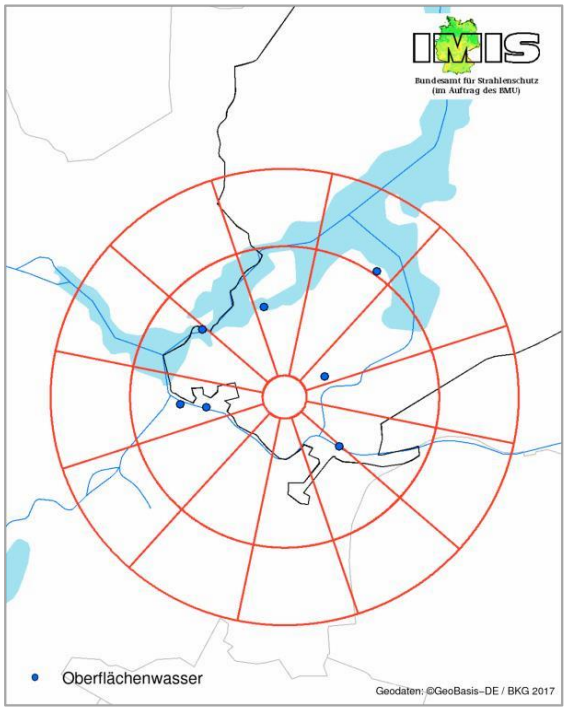

Figure 9. Sampling locations for surface waters surrounding the research reactor BER II (REI Guidelines)

Samples for the IMIS routine monitoring programme are generally combined into quarterly mixed samples and subjected to gamma spectrometric and tritium analysis. Additional analyses for ^{90}Sr and alpha emitters are also carried out for two sampling locations (Lake Müggelsee and Lake Stößensee).

In order to obtain continuous aggregate samples, automatic water samplers of the type WaterSam WS Porti 1S are used at three sampling locations (Spree-Sophienwerder, Lake Stößensee, Lake Tegel). The collection tank for the sampling location Spree-Sophienwerder is emptied by employees of the Berlin Radiation Monitoring Station every 7 to 14 days, and the containers at the two lakes are each emptied once each month.

The samplers extract samples directly from the water via a hose. This reduces the chance of malfunctions since there is no pump to get blocked, but has the disadvantage that the thin sampling lines may freeze. In the event that the temperature drops below zero, composite samples from the monthly spot samples are produced instead. Cleaning tasks are limited to the mechanical removal of foreign matter such as dirt, sediment, leaves or algae, no cleaning agents are used.

The large sample collecting containers are cleaned every one or two years using a high-pressure cleaner.

The intake device is checked whenever a sample is taken, and any consumable parts are cleaned mechanically or replaced as required. Maintenance is carried out by the Berlin Radiation Monitoring Station during sampling.

At the other three lakes (Lake Müggelsee, Lake Jungfernsee, Niederneuendorfer Lake), a spot sample of 10 to 20 l is taken once each month. Sampling is carried out using a plastic bucket with a rope or a container on a pole. Before sampling, the bucket or container is rinsed using the water to be sampled; the sample is then taken and transferred to the sample containers provided. The sample is then acidified if necessary. If several samples are taken, cross-contamination is avoided by using clean water to rinse out the container used for sampling. Typical sample volumes are 20 to 30 l for gamma spectrometry (^{40}K, ^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs, ^{144}Ce), 5 to 10 l for alpha analysis, approximately 10 l for ^{90}Sr analysis and 100 ml for ^{3}H analysis.

5.4.2 Sampling for emergency operation purposes

Where necessary, for example under the IMIS emergency monitoring programme, daily aggregate samples or spot samples may be monitored.

Under the IMIS emergency monitoring programme, depending on the event (e.g. radioactive input from precipitation), daily or weekly spot sampling is carried out, with priority given to the sampling of waters which are used as a source of drinking water (Figure 7). These include e.g. Lake Tegel (Tegel Waterworks), the Havel (Tiefwerder Waterworks), Lake Wannsee (Beelitzhof Waterworks) and Lake Müggelsee (Friedrichshagen Waterworks). The samples are subjected to gamma spectrometric analysis; 5 % of samples are also analysed for ^{3}H, ^{90}Sr and total alpha.

One sample is taken from the prescribed seven sampling locations as a bailed sample for the purpose of the annual drill for the emergency monitoring programme for incidents under the REI Guidelines, and subjected to gamma spectrometric analysis through direct measurement. Data are provided for ^{60}Co, ^{134}Cs and ^{137}Cs.

5.4.3 Groundwater and drinking water

The SMS samples drinking water and untreated water at three waterworks and groundwater at three locations using existing street pumps (Figure 10).

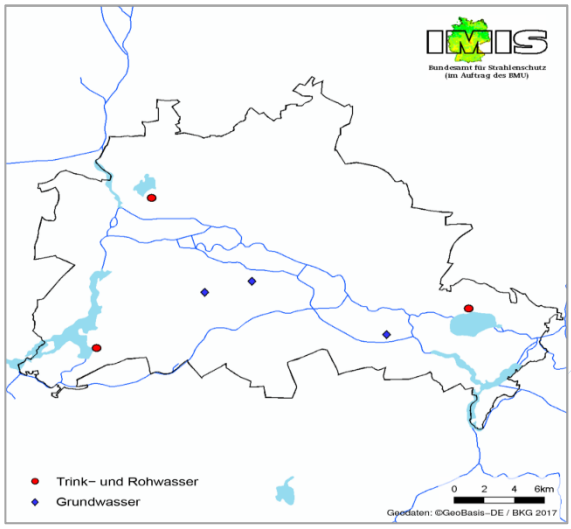

Figure 10. Sampling locations for drinking and untreated water and for groundwater in Berlin (English translation below)

DE	EN
Trink-und Rohwasser	*Drinking and untreated water*
Grundwasser	*Groundwater*

Drinking water is sampled every six months at the Tegel and Friedrichshagen waterworks and every quarter at the Beelitzhof waterworks. The untreated water at the three waterworks is also sampled once each year.

Quarterly tests are carried out on drinking water from the Beelitzhof waterworks as part of the EU's sparse network monitoring programme for the Germany-East region. Drinking water and untreated water are extracted at the waterworks as spot samples using the tap provided for this purpose. The tap runs constantly, meaning that no water needs to be drawn off before sampling. The necessary sample quantity is transferred directly to plastic containers using a hose. Samples of between 40 and 80 l are taken, depending on the relevant analysis spectrum.

Samples of groundwater are taken every six months from street pumps at three sampling locations. Approximately 100 l is drawn before taking the sample in order to flush out any standing water or deposits in the pipes.

The drinking water and groundwater samples are subjected to gamma spectrometric analysis. Additional analyses (for beta emitters (^{90}Sr) and alpha emitters (U and Pu isotopes)) are carried out for samples from two waterworks (Beelitzhof and Tegel) and at two locations for groundwater sampling (Wilmersdorf and Tempelhof).

Samples are also taken from drinking water sampling points in the event of an emergency. As part of each six-monthly drill for the monitoring programme for incidents under the REI Guidelines, a drinking water sample of 1 l is taken at the Beelitzhof waterworks and subjected directly to gamma spectrometric analysis (^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs, ^{144}Ce) without further sample preparation.

5.4.4 Drinking water tests in line with the Drinking Water Ordinance

Monitoring aimed at detecting the presence of natural radioactive substances in drinking water are carried out under federal law in line with the Drinking Water Ordinance. Competencies for the hygiene-related monitoring of drinking water in the Federal State of Berlin are regulated by the Provisions Implementing the Drinking Water Ordinance [Ausführungsvorschriften zur Durchführung der Trinkwasserverordnung, AVTrinkwV].

The test results submitted by the Berlin Water Utilities [Berliner Wasserbetriebe, BWB] for radon, tritium and the indicative dose have revealed that natural radioactive substances do not occur within the water supply area of Berlin in concentrations which suggest that the parameter values for radioactive substances in drinking water are likely to be exceeded. The Berlin Water Utilities have therefore been exempted from the initial testing obligation under the Drinking Water Ordinance by way of a decree issued by the State Office for Health and Social Affairs Berlin. An accredited laboratory in Saxony has been contracted by the Berlin Water Utilities to perform radioactivity testing. The monitoring outcomes are published by the Berlin Water Utilities on their website[11].

As a basic principle, it is not necessary to routinely test drinking water for the presence of radionuclides of artificial origin. A generic plan for a potential incident involving drinking water has been drawn up under the leadership of the Senate Department responsible for health matters. Measures have also been planned on the basis of consultations between the Berlin Water Utilities and the State Office for Health and Social Affairs Berlin and between the Berlin Water Utilities and the district health authorities. The plan is divided up into four scenarios which cover the drinking water incidents currently deemed most likely to occur within the Federal State of Berlin. These include the microbiological and chemical contamination of drinking water (including contamination with artificial radioactive substances), a scenario involving a cluster of water-borne diseases and a scenario involving major outages of the drinking water supply.

The current plan is available in electronic format in the internal section of the disaster response portal DiDaKat (Digital Data for Disaster Response; www.didakat.de), and contains the latest information updates as well as background materials and contact details. It can be accessed by all Berlin health authorities at all times.

If the parameter values (including those for radioactive substances) are exceeded, the Drinking Water Ordinance provides for the competent health authority to decide whether this may jeopardise the health of the consumers affected, and whether the operator of the relevant water supply system should be ordered to take measures. This includes e.g. the decommissioning of facilities and also the ordering of tests. Berlin Water Utilities cannot carry out tests for radioactivity at its own laboratory and must therefore assign these tasks to an appropriate laboratory.

[11] http://www.bwb.de/content/language1/html/941.php

Where necessary, the health agencies may also award contracts for testing services to the Berlin-Brandenburg Federal State Laboratory, which operates a radiation monitoring station and monitoring stations at Oranienburg and Frankfurt/Oder.

Sampling and testing methods are specified in the annexes to the Drinking Water Ordinance. The health authorities are also guided in their decision-making activities by the 'Guidelines on the testing and assessment of radioactive substances in drinking water in connection with implementation of the Drinking Water Ordinance[12] published in February 2017 by the BMUB. This document includes detailed descriptions of the sampling and monitoring procedures.

5.4.5 Waste water

Four waste water treatment plants are sampled under the IMIS monitoring programme. Depending on the plant in question, samples of purified waste water and sewage sludge are taken. In the case of the Ruhleben waste water plant, samples are also taken from the adjoining incinerator plant. The residual materials tested include sewage sludge ash as a combustion residue, filter cake, gypsum and washing water. Gamma-emitting nuclides as well as (in some cases) iodine isotopes, ^{90}Sr and alpha emitting nuclides are measured.

5.5 MONITORING OF RADIOACTIVITY IN SOIL, FLORA AND FAUNA

5.5.1 Soil

The DWD is responsible for stationary measurements of the level of radioactivity on the soil, and the BfS for mobile monitoring in this respect. Pursuant to §3 of the Precautionary Radiation Protection Act, the Federal State of Berlin is responsible for measuring radioactivity in the soil in Berlin.

Under the IMIS routine monitoring programme, grazing and arable land is sampled at two locations for each. Soils are also tested for radioactive particles deposited on the surface at no fewer than five monitoring locations. A total of ten or more measurements are carried out every year, with at least five measurements carried out at ambient dose rate stations of the Federal Office for Radiation Protection. All sampling locations in Berlin and in its vicinity are shown in Figure 12.

Six to eight additional in-situ gamma measurements per year are also carried out at points under the disaster response plan for the purpose of emissions monitoring under the drill-based monitoring programme under the REI Guidelines for incidents. These points are located in the middle and outer zone of Sectors 1 to 12. The monitoring locations used in 2006 to 2016 can be seen in Figure 13.

Within the framework of the IMIS routine monitoring programme, the Berlin Radiation Monitoring Station tests soils for the mass-related content of gamma-emitting nuclides at four sampling locations (grazing and arable land); two samples are also analysed for ^{90}Sr. Sampling takes place once or twice each year. Three additional soil samples (unworked soil) are taken and subjected to gamma spectrometric analysis each year as part of the emissions monitoring programme (normal operation) under the REI Guidelines.

Cylindrical probes (depth 12 cm) and (for arable land) a soil sampler (depth 30 cm) are available for the sampling of unworked soils (Figure 11). Several defined blocks of soil are extracted in each case. End caps are placed on the cylinders, which are transported directly to the laboratory with the soil sample. The samples from the soil sampler are transferred to a bucket. A total of approximately 3 to 6 kg of soil is removed per sample.

[12] http://www.bmu.bund.de/themen/atomenergie-strahlenschutz/strahlenschutz/atomenergie-strahlenschutz-download/artikel/leitfaden-zur-untersuchung-und-bewertung-von-radioaktiven-stoffen-im-trinkwasser-bei-der-umsetzung-der-trinkwasserverordnung/

Figure 11. Soil sampling

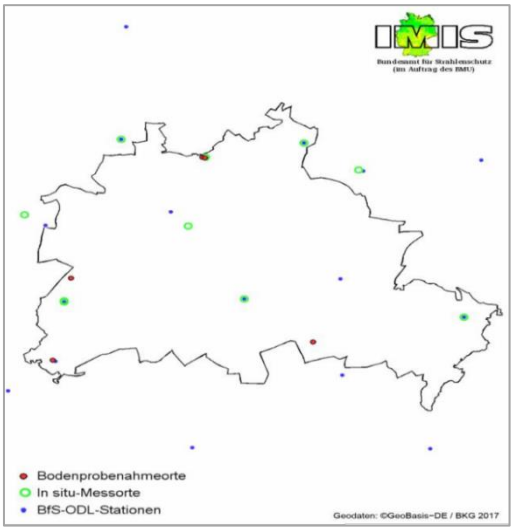

Figure 12. Soil sampling locations and in-situ monitoring locations for soil (English translation below)

DE	EN
Bodenprobenahmeorte	*Soil sampling locations*
In situ-Messorte	*In-situ monitoring locations*
BfS-ODL-Stationen	*Federal Office for Radiation Protection ambient dose rate stations*

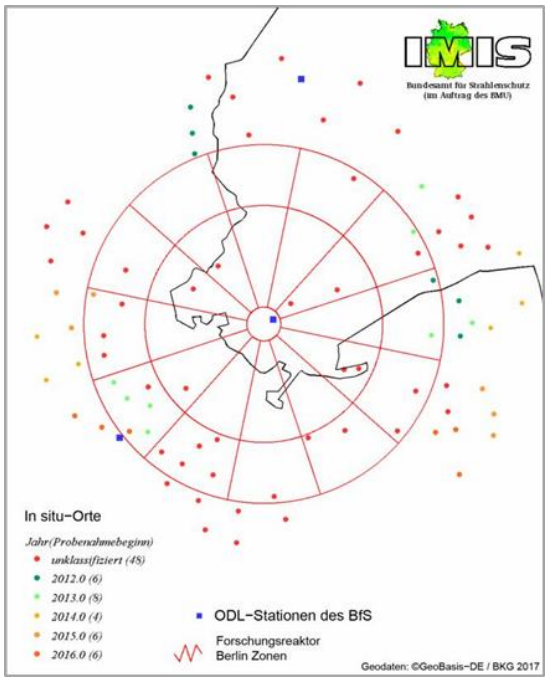

Figure 13. In-situ monitoring locations for drills carried out under the REI Guidelines for incidents 2006-2016 (English translation below)

DE	EN
In situ-Orte	*In-situ locations*
Jahr (Probenahmebeginn)	*Year (start of sampling)*
unklassifiziert	*unclassified*
ODL-Stationen des BfS	*Ambient dose rate stations of the Federal Office for Radiation Protection*
Forschungsreaktor Berlin Zonen	*Berlin research reactor zones*

5.5.2 Sediments

There are six sediment sampling locations in Berlin in lakes and on the river Spree (Figure 14) where the Fisheries Office removes sediments on a quarterly basis as spot samples for radioactivity testing.

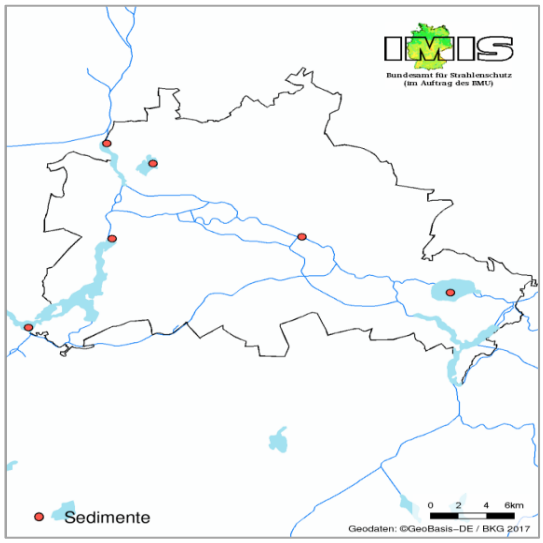

Figure 14. Sampling locations for sediment in Berlin

Sampling is carried out from a boat using a sediment grabber. The sample material obtained from approximately three individual samples (approximately 10 kg) is transferred to a sealable container and handed over to the Berlin Radiation Monitoring Station.

The sediment samples are subjected to gamma spectrometric analysis. Data are reported not only for the mandatory nuclides ^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs, ^{144}Ce, but also for ^{40}K and the nuclides of the natural decay series (^{214}Pb, ^{214}Bi, ^{228}Ac, ^{212}Pb, ^{212}Bi, ^{208}Tl).

5.5.3 Terrestrial flora and fauna

The Berlin Radiation Monitoring Station samples and analyses annually around 70 samples of terrestrial flora and fauna within the framework of the IMIS routine monitoring programme and the monitoring programmes under the REI Guidelines. For terrestrial flora, samples are taken of indicator plants (grazed grass, grass, leaves and coniferous needles) at the locations shown in Figure 15.

Samples of plant-based foodstuffs are taken predominantly from various farms, but also from other cultivated areas (such as a berry-growing farm). Allotments are also sampled under the REI Guidelines. A total of 14 sampling locations have been established for plant-based foodstuffs (fruit, vegetables and cereals), which can be seen in Figure 16. In addition, feedstuffs are sampled at the four locations of Lübars, Gatow, Dahlem and Rudow (Figure 17).

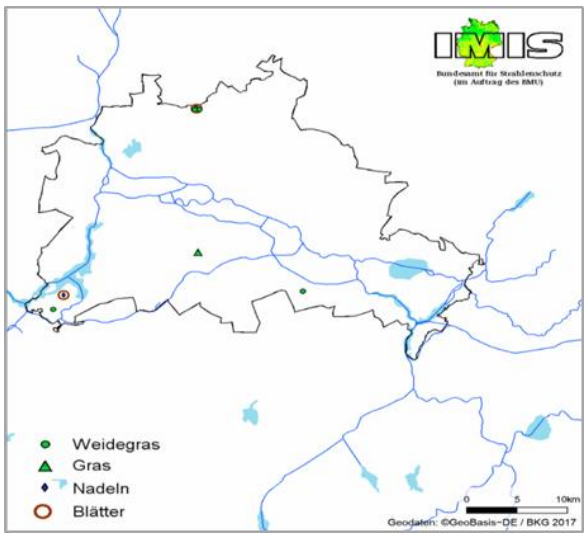

Figure 15. Sampling locations for indicator plants (English translation below)

DE	EN
Weidegras	*Grazed grass*
Gras	*Grass*
Nadeln	*Coniferous needles*
Blätter	*Leaves*

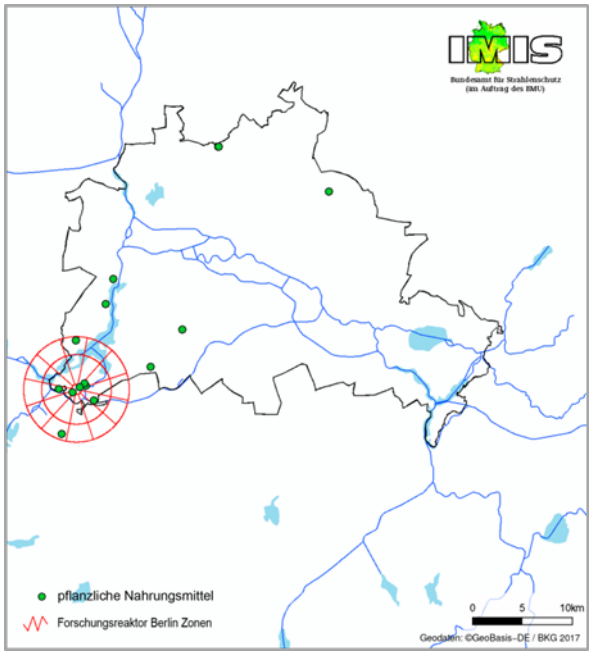

Figure 16. Sampling locations for plant-based foodstuffs (English translation below)

DE	EN
Pflanzliche Nahrungsmittel	*Plant-based foodstuffs*
Forschungsreaktor Berlin Zonen	*Berlin research reactor zones*

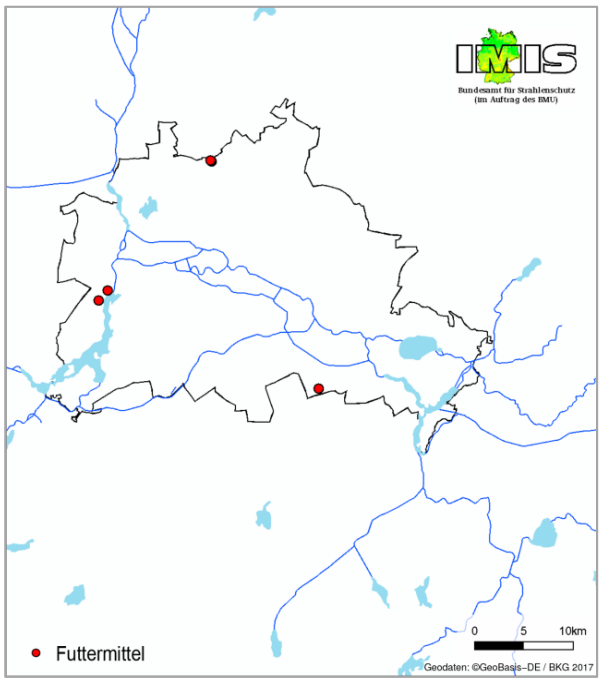

Figure 17. Sampling locations for feedstuffs (Futtermittel)

Every year two samples of grass and one sample each of beech leaves, oak leaves and spruce needles are taken and subjected to gamma spectrometric analysis as indicator media for terrestrial flora. Grazed grass is sampled a total of six times per year.

Grass and grazed grass samples are taken over a defined area (1 m^2 or more) just above the ground surface using an appropriate cutting tool, and are then transferred to a sealable collecting container (e.g. plastic bag). The sample quantity must be at least 2 kg.

Leaves are stripped from low-hanging branches shortly before they change colour in the autumn and are transferred to a plastic container. Leaves which are on the ground after having fallen off the trees the previous year are not included in the sample. The sample quantity must be at least 2 kg. Samples of coniferous needles are taken only from the current year's shoots. In order to do so, the needles are stripped from the shoots and transferred to a plastic container. The sample quantity must be at least 1 kg. Sampling takes place in autumn or winter.

Field vegetables, fruit and cereals are sampled and subjected to gamma spectrometric analysis as plant-based foodstuffs. ^{90}Sr analysis is also carried out on three samples per year. Sampling is carried out by the Veterinary and Foodstuff Supervisory Authorities or employees of the Berlin Radiation Monitoring Station.

Wherever possible, sampling is carried out directly on the farm or in the garden using botanically uniform material. Around 2 kg per sample is removed, packaged in plastic bags and transported to the monitoring station.

As well as grazed grass, feed grain (such as oats), fodder potatoes or beets and maize plants are sampled as feedstuffs. Feed grain and fodder potatoes or beets are sampled once per year, and samples of maize are taken twice per year. Around 2 to 3 kg is collected per sample. The samples are subjected to gamma spectrometric analysis.

5.5.4 Aquatic fauna

Within the framework of the IMIS routine monitoring programme and the emissions monitoring programmes under the REI Guidelines, the Berlin Radiation Monitoring Station analyses six fish samples (aquatic fauna) each year. Samples are taken at four sampling locations. These are located at Lake Müggelsee, Niederneuendorfer Lake, Sacrower Lake and around Lake Wannsee (Figure 18). Aquatic flora are not sampled. Aquatic suspended matter is tested in at least 12 samples per year under the IMIS monitoring programme, and may contain microflora.

Every year six fish samples are tested for the purpose of investigating aquatic fauna, with two samples each taken at Lake Müggelsee and Niederneuendorfer Lake and the remaining samples from Sacrower Lake and Lake Wannsee. Fish samples are provided by the Berlin Fisheries Office, the Institute of Freshwater Ecology and commercial fishermen.

Around 1.5 kg of filleted fish is required per sample, and at least 3 kg of non-filleted fish must therefore be supplied as an original sample.

Living fish are killed at the sampling location, separated into plastic bags according to species and transported to the laboratory in refrigerated conditions.

The samples are subjected to gamma spectrometric analysis. ^{90}Sr analysis is also carried out on one sample.

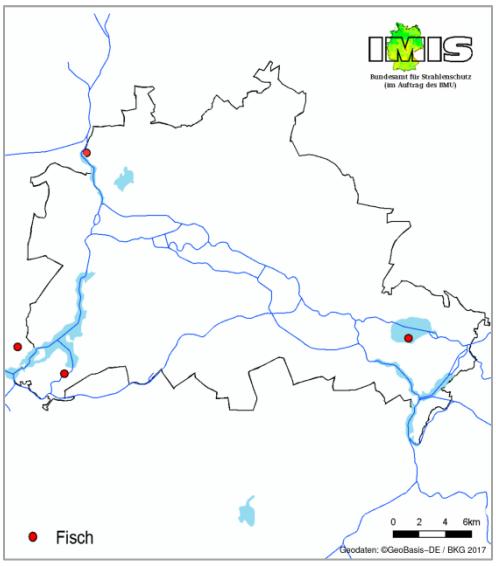

Figure 18. Sampling locations for fish (Fisch)

5.6 FOODSTUFFS AND FEEDSTUFFS

Plants, foodstuffs and feedstuffs are analysed on the basis of the National Metrology Institute nuclide library, which is updated on an ongoing basis with the latest available information. Data is reported on the following nuclides on a routine basis: ^{40}K, ^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs, ^{144}Ce. The reporting obligations for the monitoring programmes under the REI Guidelines are limited to ^{40}K, ^{60}Co, ^{134}Cs and ^{137}Cs. Any additional nuclides identified during the analyses are also reported (such as ^{7}Be).

5.6.1 Milk

Two sample collection points have been selected for raw milk; one farm in Gatow and one in Rudow. Their location can be seen in Figure 19.

The samples from Gatow are taken by the Veterinary and Foodstuff Supervisory Authority of Berlin, whereas the Berlin Radiation Monitoring Station is responsible for the samples taken in Rudow. Samples of between 2 and 4 l are taken directly from the storage container in the farm shop. The milk is placed in plastic bottles or similar appropriate containers and transported to the Monitoring Station in a coolbag. The milk samples are subjected to gamma spectrometric analysis. The samples from the farm in Berlin-Gatow are also tested for ^{90}Sr.

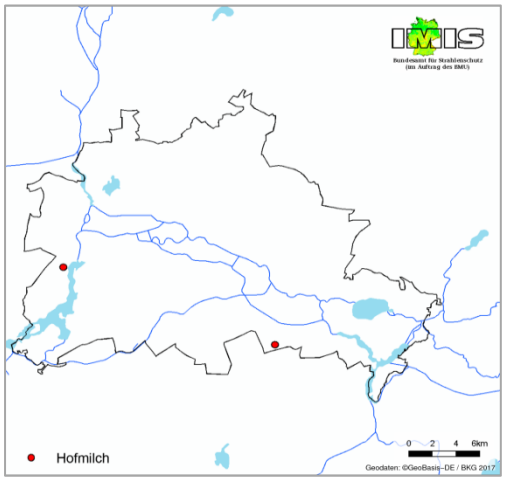

Figure 19. Sample collection points for raw milk (Hofmilch)

5.6.2 Mixed diet

The mixed diet for a healthy adult is obtained by collecting samples of all food and drink served at the Plötzensee Prison in Berlin. An example of a mixed diet sample is shown in Figure 20. Sampling is carried out with the support of the Veterinary and Foodstuff Supervisory Authority for Charlottenburg-Wilmersdorf (Berlin). Every fortnight a daily aggregate sample (in each case around 3 to 4 kg) is taken on different weekdays, and a weekly aggregate sample (around 25 kg) is taken once per quarter. The daily aggregate samples are subjected to gamma spectrometric analysis.

The weekly aggregate samples are subjected to gamma spectrometric and ^{90}Sr analysis for the EU's sparse network (region Germany-East). A sample quantity of around 25 kg in total is required to meet the more stringent requirements concerning the relevant detection limits.

The individual daily samples for each quarter are also combined into a composite sample and subjected to gamma spectrometric and ^{90}Sr analysis in line with the more stringent accuracy requirements which apply under the sparse network.

The mixed diet for infants and toddlers is tested alongside the mixed diet for adults. In order to do so, one day's food and drink is collected on a monthly basis from the paediatric ward at a Berlin hospital. These samples are subjected to gamma spectrometric analysis and also tested twice a year for ^{90}Sr.

Figure 20. Mixed diet sample for the EU's sparse monitoring programme

5.6.3 Other foodstuffs

Meat from cows, calves, pigs and poultry is also subjected to gamma spectrometric analysis as animal-based foodstuffs. Around 20 measurements are carried out for this purpose each year. The samples (around 1.5 to 2.5 kg in each case) are purchased from regional farms or acquired from a slaughterhouse.

5.6.4 Monitoring of imported foodstuffs

Routine official monitoring of foodstuffs does not involve monitoring measures aimed at detecting potential radioactive contamination. Tests may however be carried out on imported goods on the basis of Implementing Regulation (EU) 2016/6[13] following the accident at the Fukushima nuclear power station or Regulation (EC) No 1635/2006[14] and Regulation (EC) No 733/2008[15] following the accident at the Chernobyl nuclear power station.

Sampling takes place at the Veterinary Border Inspection Post [Veterinärgrenzkontrollstelle, VGKS] at the Berlin-Tegel Airport. The samples are tested at the radiation monitoring station of the Berlin-Brandenburg Federal State Laboratory in Oranienburg, which acts as a service provider accredited to carry out foodstuff testing.

5.6.5 Emergency foodstuffs monitoring

In the event of an emergency which may result in or has resulted in significant radioactive contamination of foodstuffs, the monitoring programme under the General Administrative Provisions on Precautionary Radiation Protection and Monitoring of Foodstuffs[16] enters into force on the basis of an announcement by the Federal Government. Berlin has drawn up plans for such an event which provide for example for the establishment of a coordination unit. Expert advice in the area of foodstuffs will be provided by the Senate Department for Justice, Consumer Protection and Anti-Discrimination.

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13 Commission Implementing Regulation (EU) 2016/6 of 5 January 2016 imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station and repealing Implementing Regulation (EU) No 322/2014.

14 Commission Regulation (EC) No 1635/2006 of 6 November 2006 laying down detailed rules for the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station.

15 Council Regulation (EC) No 733/2008 of 15 July 2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station

16 General Administrative Provisions implementing the monitoring of foodstuffs under Council Regulation (Euratom) No 3954/87 of 22 December 1987 laying down maximum permitted levels of radioactive contamination of foodstuffs and of feedingstuffs following a nuclear accident or any other case of radiological emergency [General Administrative Provisions on Precautionary Radiation Protection and Monitoring of Foodstuffs; AVV-Strahlenschutzvorsorge-Lebensmittelüberwachung - AVV-StrahLe].

The General Administrative Provisions on Precautionary Radiation Protection and Monitoring of Foodstuffs stipulate a shopping basket of foodstuffs which must be tested. The Federal Ministry may adjust the details of the shopping basket depending on the individual event. The number of samples to be tested is specified as at least 29 per month and 344 per year for the Federal State of Berlin. Where necessary, this figure can be increased by a factor of five by the Federal Ministry in consultation with the Senate Department for Justice, Consumer Protection and Anti-Discrimination.

Sampling is carried out by the Veterinary and Foodstuff Supervisory Authorities of the districts. An agreement concerning performance of the analyses should be sought with the Berlin Radiation Monitoring Station. Maximum levels are specified at European level in Regulation 2016/527Euratom[17] and are put into force in the event of an emergency by a European Commission implementing regulation. Pursuant to §6 and 7 of the Precautionary Radiation Protection Act[18], the BMUB is also entitled to specify maximum contamination levels; if these levels are exceeded, placement of the relevant foodstuffs on the market may be restricted or prohibited.

5.7 MONITORING UNDER THE SPARSE NETWORK PROGRAMME

Under Articles 35 and 36 of the Euratom Treaty, the Member States are obliged to carry out regular monitoring of the level of radioactivity in the environment and to forward the results to the European Commission. A distinction is made between two EU-wide networks; the dense network and the sparse network. Monitoring under the IMIS General Administrative Provisions (normal operation) meets the requirements for the dense network. The sparse network however requires a higher sensitivity of measurements. It is made up of a smaller number of selected laboratories which are representative of their individual region. The higher level of sensitivity means that any minor and long-term trends in concentrations of radionuclides can be detected.

Samples are taken for aerosols, surface waters, drinking water, milk and mixed diet. The networks differ in some cases in respect of the nuclides reported on. In view of the different monitoring procedures in the participating countries and the resulting differences in measurement sensitivities, reporting levels have been introduced to ensure data comparability. The reporting levels are such that a dose resulting from values below the reporting level ('< RL') represents around 1/2000 of the natural dose. The table below details sample types and radionuclides monitored in the sparse and dense networks. Total beta minus ^{40}K activity is specified for residual beta.

Sample type	Dense network	Sparse network
Aerosols	Total beta	^{7}Be, ^{137}Cs
Surface waters	Residual beta	^{137}Cs
Drinking water	^{3}H, ^{90}Sr, ^{137}Cs	^{3}H, ^{90}Sr, ^{137}Cs
Milk	^{3}H, ^{90}Sr. ^{137}Cs	^{90}Sr, ^{137}Cs
Mixed diet	^{90}Sr, ^{137}Cs	^{90}Sr, ^{137}Cs

The Berlin Radiation Monitoring Station is responsible for monitoring the environmental media 'mixed diet' and 'drinking water' across the region Germany-East. Sample preparation and monitoring procedures are identical to those described above. The only exception to this rule is that monitoring times are adjusted and sampling volume increased where necessary in order to achieve

[17] Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Council Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90.

[18] Act on the precautionary protection of the public against radiation (Precautionary Radiation Protection Act) of 19.12.1986 (Federal Law Gazette I p. 2610; most recently amended by Article 91 of the Ordinance of 31.08.2015 Federal Law Gazette I p. 1474.

the required level of measuring sensitivity. Figure 21 shows examples of the monitoring outcomes for mixed diet since 2014.

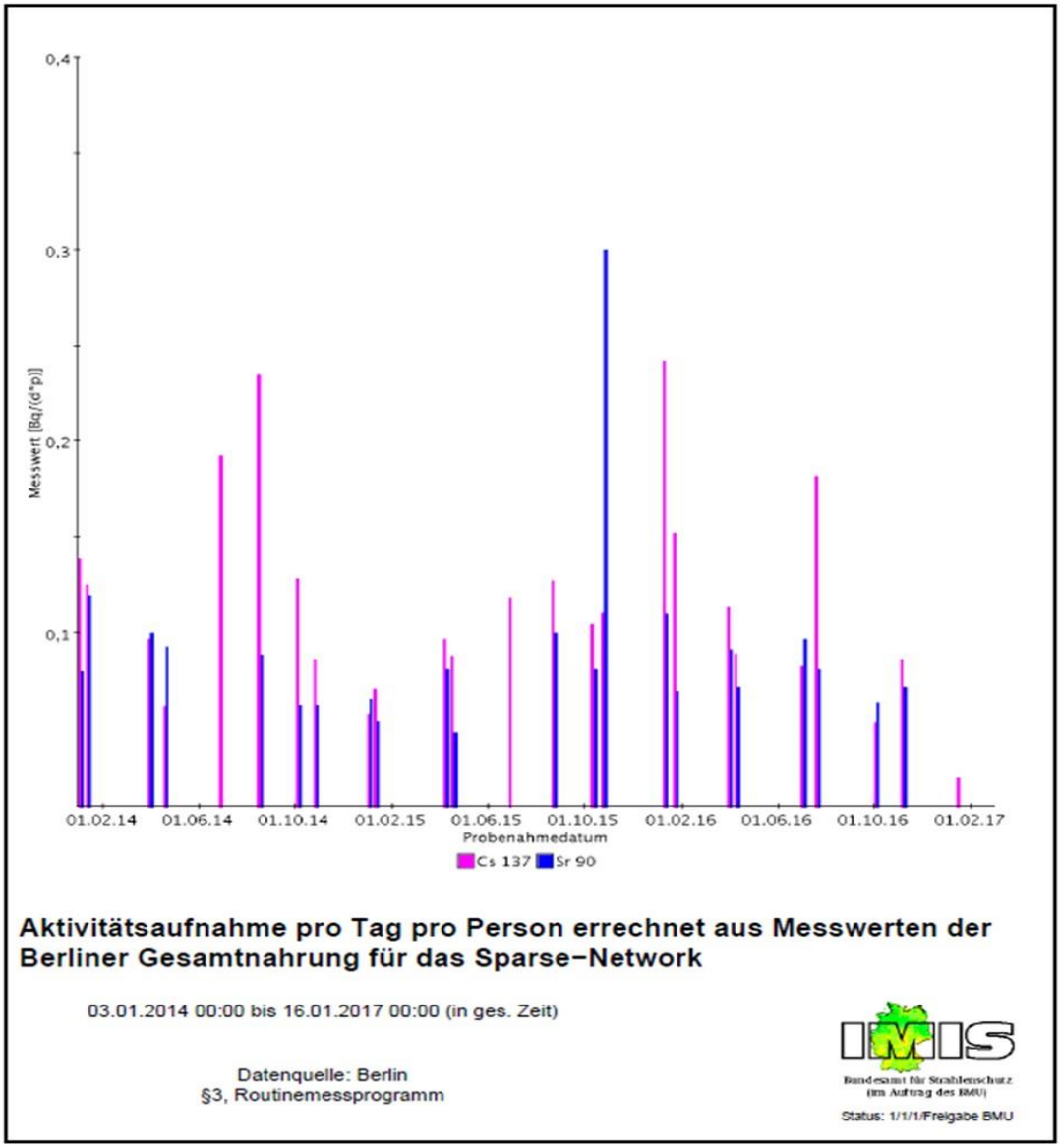


Figure 21. Monitoring outcomes for mixed diet in the sparse network, region Germany-East (English translation below)

DE	EN
*Messwert [Bq/(d*p)]*	*Measured variable [Bq/(d*p)]*
Probenahmedatum	*Sampling date*
Aktivitätsaufnahme pro Tag pro Person errechnet aus Messwerten der Berliner Gesamtnahrung für das Sparse-network	*Absorption of activity per person per day, calculated from measurements for mixed diet in Berlin for the sparse network*
03.01.2014 00:00 bis 16.01.2017 00:00 (in. Ges. Zeit)	*03.01.2014 00:00 to 16.01.2017 00:00 (in. legal time)*
Datenquelle: Berlin	*Source of data: Berlin*
§3, Routinemessprogramm	*§3, Routine monitoring programme*

5.8 PUBLIC INFORMATION

The Federal Government is responsible for publishing the results obtained from measures under the IMIS General Administrative Provisions. To this end, the BfS makes the following information available online:

- Information on the Integrated Monitoring and Information System (IMIS) for the monitoring of radioactivity in the environment: www.bfs.de/DE/themen/ion/notfallschutz/messnetz/imis/imis_node.html
- Current measurements from the Integrated Monitoring and Information System (IMIS): www.imis.bfs.de/geozg/
- Information on monitoring of the ambient gamma dose rate: www.bfs.de/DE/themen/ion/umwelt/luft-boden/odl/odl.html
- Current map of ambient gamma dose rates measured at approximately 1 800 monitoring stations in Germany: http://odlinfo.bfs.de/DE/index.html
- Information on measurements of radiation exposure in an emergency: www.bfs.de/DE/themen/ion/notfallschutz/messnetz/imis/messstrategien.html
- Information on nuclear emergency response in Germany: www.bfs.de/DE/themen/ion/notfallschutz/notfallschutz_node.html
- Information on emergency preparedness (electronic document for download or hard copy which can be ordered for postal delivery): www.bfs.de/SharedDocs/Downloads/BfS/DE/broschueren/ion/stth-notfallvorsorge.pdf
- Information on the German monitoring network for radioactivity: www.bfs.de/SharedDocs/Downloads/BfS/DE/broschueren/ion/radioaktivitaetsmessnetz.html

The competent authorities in the Federal State of Berlin inform the public about the measures taken to monitor radioactivity in the environment. This includes the publication of monthly results for the monitoring of environmental media by the SMS, information on the official monitoring of foodstuffs and analysis data from the waterworks, all of which are available online.

Senate Department for the Environment, Transport and Climate Protection

- Basic information and competencies in respect of the monitoring of radioactivity in the environment in Berlin: https://www.berlin.de/senuvk/umwelt/strahlenmessstelle/index.shtml
- Up-to-date monitoring data for environmental media and ambient dose rate monitoring: https://www. berlin.de/senuvk/umwelt/strahlenmessstelle/de/messergebnis.sht ml
- Disaster response plan for the area surrounding the research reactor: https://www.berlin.de/senuvk/umwelt/atom/de/katplan.shtml

Senate Department for Justice, Consumer Protection and Anti-Discrimination

- Information on the official monitoring of foodstuffs: https://www.berlin.de/sen/verbraucherschutz/aufgaben/gesundheitlicher-verbraucherschutz/ueberwachung-von-lebensmitteln-und-produkten/

Berlin Water Utilities

- Analysis data for waterworks: http://www.bwb.de/content/language1/html/941.php

Helmholtz Centre Berlin for Materials and Energy

- Information on the research reactor BER II: http://www.helmholtz-berlin.de/quellen/ber/index_de.html

- Information for the public in the area surrounding the research reactor: http://www.helmholtz-berlin.de/quellen/ber/ber2/sicherheit/information_de.html
- Information for the public under §53 of the Radiation Protection Ordinance: http://www.helmholtz-berlin.de/media/media/oea/aktuell/news/pdfs/hzb_notfall_brosch_15_final.pdf

6 LABORATORIES MONITORING RADIOACTIVITY IN BERLIN

6.1 BERLIN RADIATION MONITORING STATION

6.1.1 Introduction

Any laboratory tasks required for the purpose of monitoring radioactivity in the environment in Berlin are carried out by the Berlin Radiation Monitoring Station (SMS). The official Monitoring Station for Radioactivity in the Environment within the SMS employs staff on permanent contracts with the expertise necessary pursuant to the IMIS General Administrative Provisions. It has been accredited for all the main procedures under DIN EN ISO / IEC 17025 since 2016.

6.1.2 Sampling, sample acceptance and sample registration

Samples are taken on a routine basis by employees of the Berlin Radiation Monitoring Station, the Fisheries Office and by official foodstuff inspectors from the Veterinary and Foodstuff Supervisory Authorities. Only a small number of samples (such as sewage sludge) are taken by on-site personnel. Anyone involved in taking samples receives training (provided by employees of the Berlin Radiation Monitoring Station) and has access to factsheets drawn up for this purpose.

For the purpose of routine monitoring operations, the samples are received by the Incoming Sample Department of the Berlin Radiation Monitoring Station, registered using the Laboratory Information and Management System (LIMS) and labelled with a unique sample number and barcode. An accompanying document including the most important data and tests to be carried out is also produced for each sample. The laboratory then accepts the samples for testing and, if necessary, records any relevant extra data in LIMS.

In the event that an emergency situation gives rise to a large quantity of samples which may have been subject to a high level of contamination, provision is made for the registration of radioactivity samples at a separate SMS registration point. This allows more extensive interim storage of incoming samples and the performance of measurements on these samples. In an emergency situation, contamination checks on incoming samples ensure that samples with higher concentrations of radioactivity can be identified and separated out. The necessary dose rate meters for incoming sample checks are kept available.

Measurements are carried out mainly on individual samples; aggregate samples are sometimes also used in the case of water samples, and composite samples of spot samples in the case of mixed diet. The procedures to be followed when performing measurements are described in the corresponding work instructions for the QM system accredited pursuant to DIN EN ISO / IEC 17025.

6.1.3 Sample preparation

Samples are handled in line with the currently applicable work instructions for sample preparation. These work instructions set out the procedure for all environmental media to be tested and were produced on the basis of the Federal Government's monitoring instructions. Radiochemical preparation of the samples for the purpose of calculating levels of alpha and beta emitters is also carried out on the basis of the relevant work instructions.

6.1.4 Monitoring equipment

The devices listed below are available for the monitoring procedures.

Laboratory equipment

- Gamma spectrometry system
  - Manufacturer: Canberra
  - Type: Genie2000
  - Detectors: currently 11 stationary HPGe gamma detectors
  - relative efficiency: 20-44 %
  - recorded energy range: 30-1900 keV
  - Experimental calibration:
    - Eight standard measurement geometries with single- and multi-nuclide solutions from the National Metrology Institute and AEA Technology QSA GmbH or Eckert & Ziegler
    - 1 filter geometry with commercial filter preparation
    - for gas bottle with volume emitter from the National Metrology Institute
  - Mathematical calibration: LabSOCS (Monte Carlo procedure) by Canberra (routinely for seven standard measurement geometries, can be expanded at any time)
  - Analysis: internally (automatic) for standard geometries, otherwise calculations using LabSOCS
  - Monitoring times: based on the detection limit to be achieved in each case (currently ~24 - 168 h)
  - radionuclides analysed:
    - Mandatory nuclides (specification of measurement or detection limits): ^{40}K, ^{60}Co, ^{103}Ru, ^{131}I, ^{132}Te, ^{134}Cs, ^{137}Cs; ^{144}Ce
    - ^{7}Be, nuclides of the natural decay series ^{214}Pb/Bi, ^{228}Ac, ^{212}Pb/Bi, ^{208}Tl, for samples from waste water treatment plants and incineration plants also ^{75}Se, ^{99m}Tc, ^{111}In, ^{153}Sm, ^{177}Lu, ^{186}Re, ^{201}Tl and ^{202}Tl
  - Maintenance and quality assurance
    - monthly measurement of a certified control emitter (check to ensure the reproducibility of each gamma spectrometer)
    - monthly zero measurement to check background levels
- 10-chamber low-level alpha/beta gas ionisation detector (proportional counters)
  - Manufacturer: Berthold, Bad Wildbad
  - Type: LB 770
  - Calibration: Determination of efficiency using measurement preparations manufactured in the in-house laboratory on the basis of National Metrology Institute activity standards in the required measurement geometry
  - System check:
    - every six months with ^{90}Sr preparations
    - Measurement of current background level before sample measurement
    - Measurement of count rates (no automatic calculation of activity concentration at monitoring device).
  - Analysis: Calculation of results in Excel
  - radionuclides analysed: ^{90}Sr; ^{89}Sr
- Low-level liquid scintillation counter (LSC)
  - Manufacturer: Perkin Elmer
  - Type: TRI-CARB 3170TR/SL
  - Calibration: Determination of efficiency using measurement preparations manufactured in the in-house laboratory on the basis of National Metrology Institute activity standards in the required measurement geometry
  - radionuclides analysed: ^{3}H, ^{89}Sr (Cherenkov)
  - Background and efficiency factors: checked on a series-specific basis for ^{3}H

  - Analysis: Calculation in Excel of results for the count rates measured in the specified windows (ROI)
- Alpha spectrometer with four measuring chambers with 3.5 cm^2 PIPS detectors
  - Manufacturer: Canberra
  - Type: Alpha Analyst
  - Analysis: manually using the count rates measured in the relevant spectrum ranges (ROI)
  - radionuclides analysed: U, Pu and Am isotopes (nuclide-specific and if necessary Cm)
  - Calibration: Determination of efficiency using a solid ^{241}Am preparation of known activity and negligible thickness
  - Energy calibration: using a solid preparation with several alpha emitters (^{241}Am, ^{244}Cm, ^{239}Pu; energy range 5000 -5820 keV)
  - Analysis: Excel

Mobile monitoring equipment

- Monitoring vehicle with in-situ gamma spectrometry system:
  - Manufacturer: Canberra
  - Spectrometry and analysis software: automatic, Genie 2000 with in-situ software, version 2.0
  - Calibration: Efficiency calibration with ^{152}Eu point source, automatic conversion for four surface geometries
  - Maintenance and quality assurance: standard calibration each working day
  - (energy calibration and check of efficiency calibration) using ^{152}Eu point source at a defined distance on crystal axis
  - Analysis: automatic
- Local and personal dosimeters with scintillation sensor
  - Manufacturer: Automess
  - Type: 6150 AD 6 (monitoring device) and 6150 AD –b/E (sensor)
  - Calibration: Determination of ambient equivalent dose H*(10) using a ^{137}Cs test emitter
  - Measured variable: Dose rate in Sv/h
  - Energy range: 20 keV to 7 MeV
  - Detection limit: 100 nSv/h
  - Measurement 1m above ground level, measurement time 120 seconds
  - Analysis: automatic (inside the device)

6.1.5 Procedure followed for values below the detection limits

The procedure followed for values below the detection limits is defined within the framework of the documentation of monitoring outcomes pursuant to the IMIS General Administrative Provisions and the REI Guidelines. The procedure corresponds to the requirements of the REI Guidelines and DIN ISO 11929. According to these requirements, values below the decision threshold should be specified as '< detection limit', with the relevant detection limit stated instead of 'detection limit'. In the case of values which are above the decision threshold but below the detection limit, the value is specified together with the measurement uncertainty. This procedure will be implemented also in RAMIS (Until this requirement is implemented, all measured values below the detection limit are stated as '< detection limit').

6.1.6 Data storage

The results of all measurements are entered into the RAMIS system. An overview of the processes can be seen in Figure 22. A b3h file is generated by the analysis software and read into the RAMIS system for this purpose. The results are then exported to the IMIS system using an LAF file ("Labordaten-Austausch-Format", laboratory data exchange format), and are then available via IMIS

for all authorised organisations and bodies. The results of environmental media monitoring are also made freely available via the Internet each month[19].

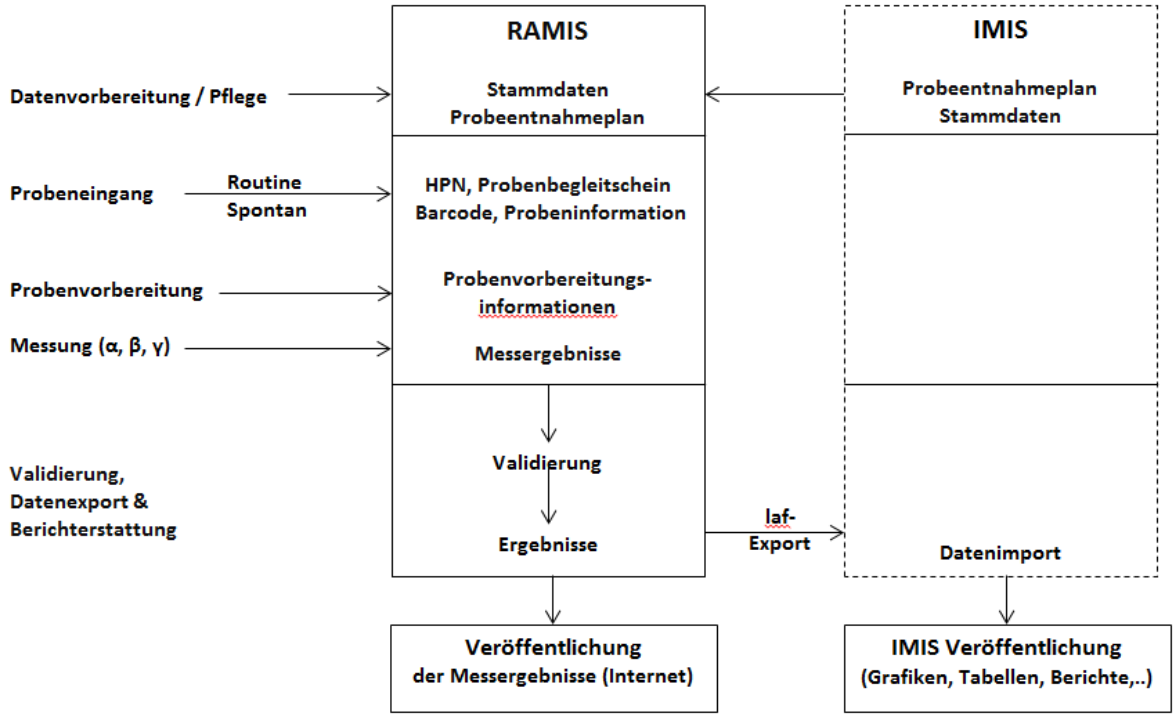


Figure 22. Data processing within the framework of the IMIS (English translation below)

DE	EN
Datenvorbereitung/Pflege	*Data preparation/updates*
Probeneingang	*Incoming samples*
Routine	*Routine*
Spontan	*Ad-hoc*
Probenvorbereitung	*Sample preparation*
Messung (α, β, γ)	*Monitoring (α, β, γ)*
Validierung, Datenexport & Berichterstattung	*Validation, data export and reporting*
RAMIS	*RAMIS*
Stammdaten *Probeentnahmeplan*	*Master data* *Sampling plan*
HPN, Probenbegleitschein *Barcode, Probeninformation*	*HPN, sample report* *Barcode, sample information*
Probenvorbereitungsinformationen	*Sample preparation information*
Messergebnisse	*Monitoring outcomes*
Validierung	*Validation*
Ergebnisse	*Outcomes*
Veröffentlichung der Messergebnisse (Internet)	*Publication of monitoring outcomes (Internet)*
laf-Export	*LAF export*
Probeentnahmeplan Stammdaten	*Sampling plan* *Master data*
Datenimport	*Data import*
IMIS Veröffentlichung (Grafiken, Tabellen, Berichte,...)	*IMIS publication (graphics, tables, reports, etc.)*

[19] http://www. berlin.de/senuvk/umwelt/strahlenmessstelle/de/messergebnis.shtml

Data is stored in both paper and digital form. The accompanying documents or acceptance slips for samples are archived. A digital copy of all current α and γ spectrum files is stored each working day on the server (Figure 23). The spectrum files are archived on the server on a monthly basis. They are stored for an unlimited period. A RAMIS database export is generated each working day and written to a physical tape together with the entire contents of the hard drive. The current back-up tapes are stored in a separate geographical location to the server. A back-up tape is also stored and archived every one or two months.

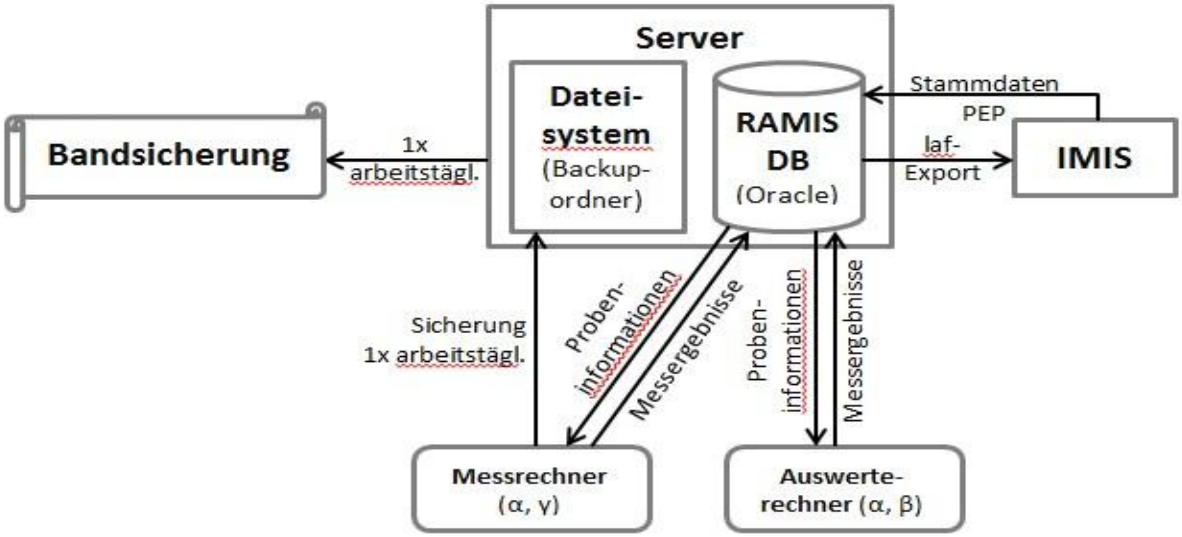


Figure 23. Overview of data management at the Radiation Monitoring Station (English translation below)

DE	*EN*
Bandsicherung	*Tape back-up*
1x arbeitstägl.	*1x working day*
Server	*Servers*
Dateisystem (backupordner)	*File system (backup folder)*
RAMIS DB (Oracle)	*RAMIS DB (Oracle)*
Stammdaten PEP	*Master data PEP*
laf-Export	*LAF export*
Sicherung *1x arbeitstägl.*	*Back-up* *1x working day*
Probeninformationen	*Sample information*
Messergebnisse	*Monitoring outcomes*
Messrechner (α, γ)	*Monitoring computer (α, γ)*
Auswerterechner (α, β)	*Analysis computer (α, β)*

6.1.7 Quality management system

A QM system pursuant to ISO/IEC 17025:2005 has been put in place at the SMS in order to provide a long-term guarantee of the constantly high quality of the services offered and to supply evidence thereof. This ensures the continuous planning, control and monitoring of every activity which may affect the quality of the results.

The Berlin Radiation Monitoring Station is accredited in its areas of work under DIN EN ISO/IEC 17025:2005. It meets all the quality requirements pursuant to the IMIS General Administrative Provisions. The last accreditation (from 26.10.2016) is valid until 25.10.2021.

External audits of the Berlin Radiation Monitoring Station pursuant to DIN EN ISO/IEC 17025:2005 (monitoring or reaccreditation audits) are carried out on a regular basis by the German Accreditation

Body [Deutsche Akkreditierungsstelle GmbH, DAkkS], which is authorised to perform these tasks in Germany.

Internal audits are carried out in line with the audit programme drawn up for the current year. The audit programme contains information on the areas to be checked and responsibilities and deadlines, and ensures that each area of the Berlin Radiation Monitoring Station's QM system is checked every 12 months as a basic principle.

QM system documents are divided into documents for specification purposes and documents for verification purposes, and are subject to documentary control:

- Internal specification documents include all requirements documented by the Berlin Radiation Monitoring Station in relation to its organisational structure and processes, such as procedural and work instructions. The procedural instructions cover inter alia procedures for measurement uncertainty, calibration or routine monitoring of radioactivity in the environment. All relevant work processes are documented in work instructions which qualify as internal specification documents within the QM system and are subject to documentary control.
- Verification documents include records of outcomes which are relevant to the QM system or evidence of activities which have been carried out. These include both quality-related and technical records.

The Berlin Radiation Monitoring Station participates on a scheduled basis in interlaboratory testing and comparative measurements for all routine tests insofar as this is possible.

6.2 BERLIN-BRANDENBURG FEDERAL STATE LABORATORY

6.2.1 Introduction

The Berlin-Brandenburg Federal State Laboratory carries out monitoring of levels of radioactivity in imported samples (third-country border checks) in its capacity as a service provider. The laboratory was established on the basis of a treaty between the Federal States of Berlin and Brandenburg signed on 30 September 2008 as a jointly financed public-law institution with legal capacity. As an independent, state-funded and accredited provider of testing services, the Berlin-Brandenburg Federal State Laboratory perform tasks primarily on behalf of public administration bodies (around 95 % of tasks and activities) and assists the Federal States of Berlin and Brandenburg with their official tasks.

The many different tests and activities which the Berlin-Brandenburg Federal State Laboratory performs for different authorities in Berlin and Brandenburg have been assigned by law. Official tasks are carried out primarily in consumer health protection, environmental health protection, pharmaceutical products, veterinary activities, environmental monitoring, agriculture and geology. Around 890 000 samples are tested each year in total at the Berlin-Brandenburg Federal State Laboratory.

6.2.2 Sample acceptance, recording and registration

The contracting authority (the Tegel Veterinary Border Inspection Post) notifies the Oranienburg Radiation Monitoring Station of the Berlin-Brandenburg Federal State Laboratory by telephone before submitting imported samples for monitoring. Transportation of samples is the responsibility of the Berlin-Brandenburg Federal State Laboratory. The Tegel Veterinary Border Inspection Post is responsible for taking the actual samples. The Oranienburg Radiation Monitoring Station carries out radioactivity monitoring (^{134}Cs, ^{137}Cs) on behalf of the Tegel Veterinary Border Inspection Post in its capacity as a contracted provider of testing services, and forwards the measurements immediately by telephone/fax to the contracting authority. The written test report containing the measurements is forwarded at a later date to the Tegel Veterinary Border Inspection Post.

When the samples are received by the Radiation Monitoring Station they are registered on the Laboratory Information System (LDIS) and assigned a unique main sample number; an accompanying document is also produced for each sample. Owing to the urgent nature of the procedure, there is no interim storage of samples; the importer's goods may only leave Berlin-Tegel Airport or the Veterinary Border Inspection Post when the laboratory has confirmed that they comply with the limit values. After the samples have been received and registered, they immediately undergo preparation and monitoring.

6.2.3 Sample preparation

Samples are prepared in line with internal work instructions which are based on the monitoring regulations of the BMUB on the monitoring of radioactivity in the environment.

6.2.4 Laboratory equipment

The gamma spectrometry monitoring method is accredited by the German Accreditation Body. The gamma spectrometers and the associated detectors for foodstuff samples are listed in the table below.

Detector No	Type	Manufacturer	Rel. eff. [%]	FWHM [keV] at 1332.5 keV	Monitoring/calibration geometry
1	p-Type, HPGe	ORTEC	35.7	1.83	1-l-Marinelli
2	p-Type, HPGe	ORTEC	39.9	1.75	1-l-Marinelli
3	p-Type, HPGe	ORTEC	47.6	1.96	1-l-Marinelli
4	n Type, HPGe	Canberra	27.7	1.88	1-l-Marinelli
5	p-Type, HPGe	Canberra	32.1	2.17	1-l-Marinelli
6	p-Type, HPGe	ORTEC	26.8	1.85	1-l-Marinelli
7	p-Type, HPGe	ORTEC	31.1	2.32	1-l-Marinelli
8	p-Type, HPGe	ORTEC	27.9	1.73	1-l-Marinelli
9	p-Type, HPGe	ORTEC	39	2.2	1-l-Marinelli

Detectors 4+5 are connected to a new Dspec 502 manufactured by Ortec. The measurement results are calculated automatically by the Ortec GammaVision software. Accuracy, reproducibility and calibration are controlled weekly using a mixed nuclide standard (^{133}Ba, ^{57}Co, ^{139}Ce, ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{60}Co, ^{88}Y). Background measurement is performed monthly.

6.2.5 Data storage

The monitoring system prints out an analysis report which is used as a basis for the manual production of a test report. The monitoring system also transfers the results to the laboratory's own laboratory information management system as an export file. The analysis report is stored as a hard copy together with the accompanying document for the sample. There is no obligation for the laboratory to store the data or return the sample as the provider of testing services for the Tegel Veterinary Border Inspection Post; this is the sole responsibility of the contracting authority. The raw data and logs are destroyed after a period which is suitably long to allow any queries to be answered.

6.2.6 Quality assurance

With the exception of the testing areas 'human infection diagnostics' and 'testing of medical products', the Berlin-Brandenburg Federal State Laboratory was accredited by the German Accreditation Body as a test body with effect from 17 July 2013 for a period of five years.

The Oranienburg monitoring station participates in the following interlaboratory tests (^{134}Cs, ^{137}Cs): waste water from nuclear facilities (coordinating by BfS) and raw milk (coordinated by the Max Rubner Institute, Federal Research Institute of Nutrition and Food, Kiel). Internal audits are carried out on a regular basis.

6.2.7 Procedure followed for values below the detection limits

Unless otherwise agreed with the contracting authority, values below the detection limits are specified as '< detection limit', with the value of the detection limit entered instead of 'detection limit'. Since the monitoring activities carried out on behalf of the Tegel Veterinary Border Inspection Post measure compliance with limit values (e.g. ^{137}Cs 600 Bq/kg or 370 Bq/kg), and this requirement is met conservatively if the detection limit + uncertainty is below the limit value, the problem of values between the decision threshold and the detection limit is irrelevant. For regular counting times, the detection limit is several orders of magnitude lower than the limit values.

7 MOBILE MONITORING BY OTHER AUTHORITES AND INSTITUTIONS IN BERLIN

The mobile radiological monitoring which is performed by the Federal State of Berlin is supported by various organisations, including in particular the Berlin Fire Brigade, the Berlin Criminal Investigation Department of the Berlin Police, the German Red Cross and the Helmholtz Centre Berlin.

7.1 CBRN EXPLORATION VEHICLE

Monitoring is carried out using a CBRN exploration vehicle for the monitoring, sensing and recording of chemical, biological, radioactive and nuclear contamination. A total of 14 identical CBRN exploration vehicles (Figure 24) are stationed in Berlin at the Berlin Fire Brigade, the Criminal Investigation Department of the Berlin Police, the German Red Cross[20], the German rescue services and the Technisches Hilfswerk.

Figure 24. CBRN exploration vehicle

The radiological monitoring system of the CBRN exploration vehicle includes the following equipment:

- dose rate meter FH 40 G -10
  - Monitoring range: 500 nSv/h – 1 Sv/h
  - Energy range: 30 keV – 4.4 MeV
- NBR sensor FHZ 672-2 (Natural Background Rejection)
  - Monitoring range: 10 nSv/h – 100 µSv/h
  - Energy range: 60 keV – 2 MeV
- Analysis: integrated software
- Data transmission: using UMTS to GeoFES

[20] The CBRN service operated by the Berlin branch of the Red Cross Berlin is unusual in that all posts are filled by volunteers.

The CBRN exploration vehicle is able to distinguish between natural and artificial radiation and carry out dose rate mapping while driving. The transmission structure for secure transmission of data from the individual vehicle to a common data centre is provided by the Berlin Fire Brigade. A data connection is established to the corresponding servers of the Fire Brigade every four minutes for data transmission purposes, using a VPN connection via UMTS. A file with a pre-defined name is transmitted. The file contains the data which have been collected (including date, time, coordinates in UTM and monitoring data from the sensors in µSv/h). The data are then forwarded to the coordinating office and also to mobile analysis vehicles of the fire brigade and the command vehicle of the Criminal Investigation Department of the Berlin Police. The data are transferred to and displayed in GeoFES.

In the event of an emergency, the affected area is investigated by the CBRN exploration vehicle. The area is narrowed down after the radioactive cloud has passed through (i.e. Phase 2), starting from the peripheral zones. The relevant sectors are specified by the situation centre of the Radiation Monitoring Body on the basis of the prevalent direction of dispersion. In the event of an emergency, these sectors are notified to the Berlin Fire Brigade headquarters. The CBRN exploration vehicles which are deployed are coordinated by a duty manager for monitoring operations from the Berlin Fire Brigade.

7.2 GeoFES software

GeoFES, a software tailored to deployment planning and surveillance, is available for use by the deployed members of the police and fire services. GeoFES allows the command centre to carry out map-based control and evaluation. A sample view of the interface can be seen in Figure 25. Using an appropriate module, various functions can be implemented such as imports of monitoring data from multiple CBRN exploration vehicles, the use of filter functions (on the basis of ambient dose rate, artificial radiation, time, vehicle or area), geographical interpolation of the data and identification and analysis of hazard zones. BfS can access the central data pool in GeoFES, and the situation centre at the Radiation Measurement Body will soon also have access to this data.

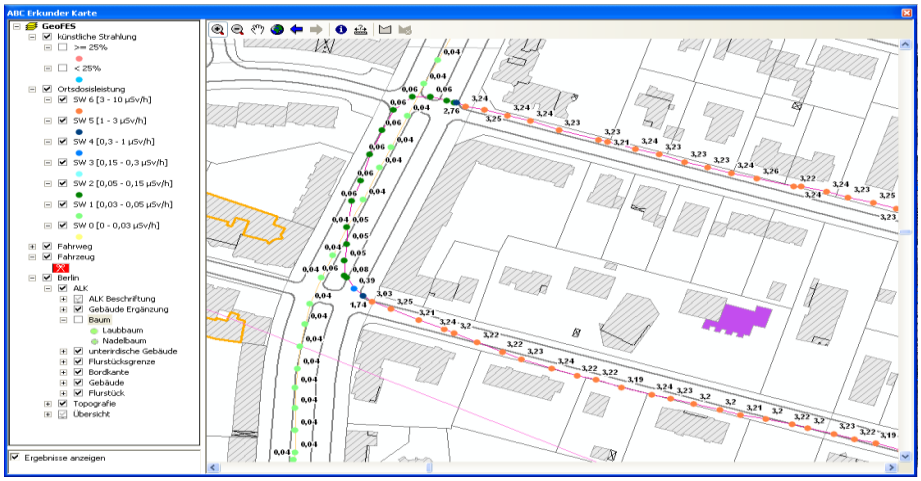


Figure 25. User interface of GeoFES

7.3 Mobile measurements by the Helmholtz Centre Berlin in the event of an emergency

In the event of an emergency, specified monitoring locations for the BER II are visited in accordance with the disaster response plan. Five people are currently trained to carry out monitoring and analysis tasks using the measurement vehicle. Sampling involves a collection time of 2 to 10 minutes, followed by analysis inside the vehicle. The activity concentrations of ^{131}I (gaseous) and aerosols (nuclide-specific) are monitored. During normal operation, one expedition is carried out per month and per sector/central zone. The following equipment is available in the vehicle:

- Mobile gamma spectroscopy system

- Detector (gamma spectroscope): Falcon 5000 (Canberra), HPGe-based
- Efficiency: relative efficiency 20 - 44 %
- FWHM @1332 keV: 1.8keV
- Quality assurance: using EuNa standard (according to manufacturer's specifications)
- Ambient dose rate sensor: NBR sensor (Thermo Fisher Scientific)
- Analysis: using Genie 2000 (Canberra)
- Data transmission: wireless / via telephone to the command centre of the Helmholtz Centre Berlin

8 MONITORING SYSTEM FOR THE RESEARCH REACTOR BER II

Between 1986 and 1991, the research reactor BER II of the Hahn Meitner Institute (nowadays the Helmholtz Centre Berlin for Materials and Energy) was renovated and its thermal output increased from 5 to 10 MW. The operating permit issued on 25.03.1991 for the BER II incorporated a requirement to install a reactor remote monitoring system within one year. The system was intended to act as a surveillance tool which could also be used for emergency response purposes. The BER II was the first research reactor in Germany fitted with a remote monitoring system of this kind.

The system was commissioned for the first time in September 1992 and has supplied data continuously ever since. The system has been expanded over time to include other monitored parameters, and the number of visualisation stations within the Berlin administration has also increased. Key expansion measures were carried out in 2014 with the integration of an ambient dose rate monitoring network located close to the facility with 18 monitoring sensors, and access to the measurements from sensors within the IMIS ambient dose rate monitoring network within a 30 km radius.

The remote monitoring system implemented for the research reactor BER II takes account of the fact that the facility to be monitored is a reactor operating at low temperatures and zero pressure, and that its output and radioactive inventory are lower than a power-generating reactor by a factor of around 400. The remote monitoring system is therefore only comparable to a limited extent to the systems for power-generating reactors. The Framework Recommendation on the remote monitoring of nuclear power plants was however taken into account on a mutatis mutandis basis.

8.1 MONITORED PARAMETERS

The reactor remote monitoring system records facility parameters, radiological measurements from the facility, emissions data, weather data from a SODAR system and a precipitation monitoring station, data from two ambient monitoring stations within the grounds of the Helmholtz Berlin Centre and ambient dose rate data from a monitoring network ring in the area surrounding the facility and the ambient dose rate sensors of the IMIS monitoring network located in a 30 km radius.

Facility parameters

- Reactor power
- Fill level of reactor pool
- Negative pressure in reactor hall
- Air throughput in stack

Radiological measurements from facility

- Concentration of radioactive noble gases in beam pipe exhaust
- Ambient dose rate reactor bridge
- Pool extraction reactor hall
- Noble gas concentration reactor hall
- Noble gas concentration experiment hall

- Activity in intermediate cooling circuit
- Ambient dose rate E Hall South

Weather data (SODAR)

- Wind speed
- Wind direction
- Turbulence (standard deviation of vertical wind speed) at a height of 50 m
- Precipitation intensity

Wind speed and turbulence are also used to calculate the stability category (A-F) required for the dispersion calculations. Dispersion conditions are determined on the basis of KTA 1508 ('Tools for determining the dispersion of radioactive substances in the atmosphere').

Emissions data

Emissions monitoring of the BER II takes place in line with KTA 1507 ('Monitoring of discharges of radioactive substances from research reactors'). Some of the monitoring data is also used for the reactor remote monitoring system.

A representative bypass flow for the monitoring of emissions of radioactive substances is branched off from the stack's exhaust duct.

- Concentration of radioactive noble gases (Bq/m^3), discharge of radioactive noble gases (Bq/h), with one sensor each for normal operation and emergency operation
- Concentration of radioactive aerosols (Bq/m^3), discharge of radioactive aerosols (Bq/h)
- Concentration of radioactive iodines, aerosols and gas (Bq/m^3)
- Concentration of artificial radioactive aerosols (Bq/m^3), discharge of artificial radioactive aerosols (Bq/h), five-day delayed monitoring to differentiate between artificial and natural isotopes

Emissions data from facility grounds

- MS2 East, concentration of radioactive aerosols, β total (Bq/m^3),
- MS2 East, concentration of radioactive aerosols, β artificial (Bq/m^3),
- MS2 East, ambient dose rate (normal and high-dose range)
- MS4 North, concentration of radioactive aerosols, β-total (Bq/m^3),
- MS4 North, ambient dose rate (normal and high-dose range)
- Electronics Building South, ambient dose rate

8.2 AMBIENT DOSE RATE DATA FROM THE SURROUNDING AREA

Data from the ambient dose rate sensors positioned in the area surrounding the grounds of the Helmholtz Berlin Centre are used exclusively for disaster response purposes. They are not sensitive enough to monitor the normal operation of the facility or to determine natural radioactivity in the environment. The high-dose sensors are not suitable for monitoring low radiation levels, since their monitoring range is designed for increased dose rates up to 10 mSv.

A total of 12 sensors are positioned around the facility within a distance of approximately 4 km in such a way that each 30-degree sector is covered by one sensor. There are also six additional sensors in the heavily populated urban areas of Berlin-Wannsee and Potsdam-Babelsberg. The distribution of the sensors can be seen in Figure 25.

Measurements are transmitted unidirectionally via a UHF data connection. All data from the past two hours are transmitted every 10 minutes in order to avoid any gaps in documentation. Additional measurements from previous transmissions over the past 14 days are also transmitted (at incrementally longer intervals). This ensures that all values are transmitted in full, even if the

reception signal weakens temporarily. An alarm is raised immediately if a threshold value is exceeded.

- Ambient dose rate sensors for the reactor remote monitoring system at the Helmholtz Centre Berlin
  - Manufacturer: Saphymo
  - Type: GammaTRACER Basic
  - Measured value: Ambient dose equivalent H*10 (nSv/h)
  - Monitoring range: 20 nSv/h – 10 mSv/h (redundant design)
  - Monitoring cycle length: adjustable 1, 2, 5, 10, 15, 30, 60, 120 min
  - Automatic cycle switching with freely selectable ambient dose rate threshold value
  - Memory: 12 000 measurements
  - battery-operated (replacement ~3 years for 10 min. monitoring cycle)
  - Calibration: Checked every 3 years, if necessary one-point calibration at ~3 µGy/h
  - Quality assurance: ^{137}Cs test emitter
  - Data transmission: 10 min. cycle, via UHF to PDC (Primary Data Centre)
    - Transmitter: via DataGATE-Basic/IR interface
    - Receiver: ShortLINK Receiver (Genitron)
  - Data management: DataEXPERT (package including database, data analysis and documentation)

Additional 14 sensors within the IMIS ambient dose rate monitoring network supply data from a radius of 30 km around the facility.

Figure 25. Ambient dose rate sensors in the area surrounding the Helmholtz Centre Berlin. *The two aerosol monitoring stations MS2 and MS4 within the grounds of the Helmholtz Centre Berlin (dark green) and an IMIS ambient dose rate sensor (light green) can also be seen. (English translation below)*

DE	EN
SODAR – Wetterdaten von 21.03.17 13:50	*SODAR – weather data from 21.03.17 13:50*
Wind aus 223,5°	*Wind from 223.5°*
Windgeschwindigkeit 4,54 m/s	*Wind speed 4.54 m/s*

Turbulenz 0,53 m/s	*Turbulence 0.53 m/s*
Diff-Kategorie 3 (1=A, 6=F)	*Diffusion category 3 (1=A, 6=F)*
Temperatur 11,0°C	*Temperature 11.0°C*
RFÜ - Tabelle	*Reactor remote monitoring system - Table*
IMIS-ODL Tabelle	*IMIS ambient dose rate table*
IMIS - ODL	*IMIS ambient dose rate*
Reaktor	*Reactor*
Lageplan HMI	*Site map HMI*
Lageplan HMI Google	*Site map HMI Google*
Messwerte von 21.03.17 13:50	*Measurements from 21.03.17 13:50*
Beschreibung Messstellen	*Description of monitoring stations*
nördliche IMIS Sonden	*northern IMIS sensors*
westliche Sektoren	*western sectors*
östliche Sektoren	*eastern sectors*

8.3 DATA COLLECTION

All the data from the research reactor processed within the reactor remote monitoring system are generated by the operator's own monitoring devices; the current signals from these devices are decoupled using isolation amplifiers and transformed into physical measurements at the coordinating control centre (Figure 27). The one-minute values are forwarded from the computer which collects the measurements to the control centre (as 11-bit current signal values), and the latter exchanges monitoring data with the IMIS via FTP. Redundant data transmission (to the fire brigade control centre) takes place in parallel to the transmission of data to the coordinating centre system. The data can be viewed directly at the coordinating control centre using a visualisation station, which has the relevant software installed. The authorities involved in disaster response planning for the area surrounding the research reactor have additional visualisation stations connected via a gateway.

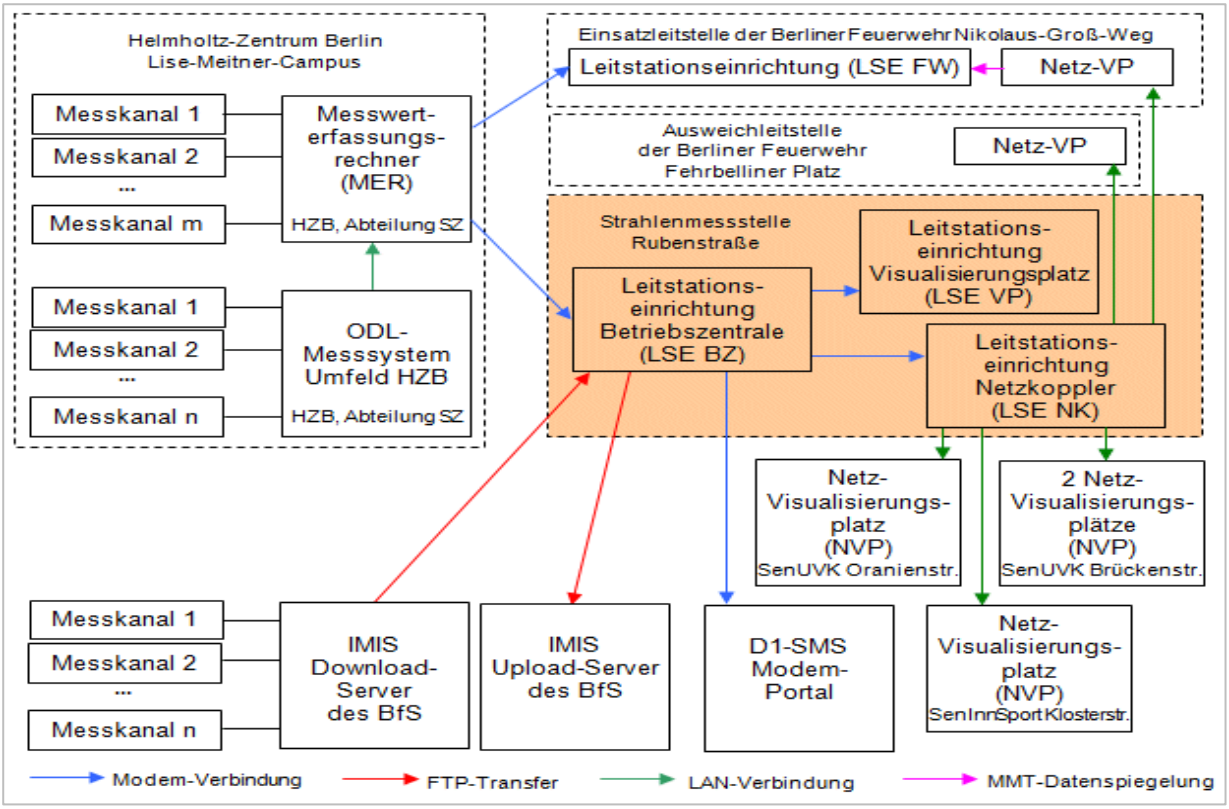


Figure 27. Structure of the remote monitoring system for the research reactor BER II (English translation below)

DE	*EN*
Helmholtz-Zentrum Berlin Lise-Meitner-Campus	*Helmholtz Centre Berlin Lise Meitner campus*
Messkanal	*Monitoring channel*
Messwerterfassungsrechner -(MER) HZB, Abteilung SZ	*Computer used to record measurements (MER) Helmholtz Centre Berlin, Department SZ*
ODL-Messsystem Umfeld HZB HZB, Abteilung SZ	*Ambient dose rate measuring system in the area surrounding the Helmholtz Centre Berlin Helmholtz Centre Berlin, Department SZ*
Einsatzleitstelle der Berliner Feuerwehr Nikolaus-Groß-Weg	*Berlin Fire Brigade coordinating control centre Nikolaus-Groß-Weg*
Leitstationseinrichtung (LSE FW)	*Coordinating centre system (LSE FW)*
Netz-VP	*network visualisation station*
Ausweichleitstelle der Berliner Feuerwehr Fehrbelliner Platz	*Berlin Fire Brigade alternative coordinating centre Fehrbelliner Platz*
Strahlenmessstelle Rubenstraße	*Radiation Monitoring Station Rubensstraße*
Leitstationseinrichtung Betriebszentrale (LSE BZ)	*Coordinating centre system control centre [Leitstationseinrichtung Betriebszentrale, LSE BZ]*
Leitstationseinrichtung Visualisierungsplatz (LSE VP)	*Coordinating centre system visualisation station [Leitstationseinrichtung Visualisierungsplatz, LSE VP]*
Leitstationseinrichtung Netzkoppler (LSE NK)	*Coordinating centre system gateway (Leitstationseinrichtung Netzkoppler, LSE NK]*
Netz-Visualsierungsplatz (NVP) SenUVK Oranienstr.	*Network visualisation station [Netz-Visualisierungsplatz, NVP] Senate Department for the Environment, Transport and Climate Protection Oranienstraße*
2 Netz-Visualisierungsplätze (NVP) SenUVK Brückenstr.	*2 network visualisation stations Senate Department for the Environment, Transport and Climate Protection Brückenstraße*
IMIS Download-Server des BfS	*IMIS Federal Office for Radiation Protection download server*
IMIS Upload-Server BfS	*IMIS Federal Office for Radiation Protection upload server*
D1-SMS Modem-Portal	*D1-SMS modem portal*
Netz-Visualisierungsplatz (NVP) SenInnSport Klosterstr.	*Network visualisation station [Netz-Visualisierungsplatz, NVP] Senate Department for Interior Affairs and Sport Klosterstraße*
Modem-Verbindung	*Modem connection*
FTP-Transfer	*FTP transfer*
LAN-Verbindung	*LAN connection*
MMT-Datenspiegelung	*MMT data mirroring*

8.4 ALARMS

The operations centre of the reactor remote monitoring system for the research reactor is only staffed during working hours. In the event that the limits are exceeded or not met, an alarm is automatically triggered via text message to on-call teams (the composition of which has been determined in advance). After verifying the parameters which gave rise to the alarm, any measures necessary are initiated by the responsible employee.

9 EMERGENCY MONITORING FOR THE RESEARCH REACTOR BER II

9.1 INTRODUCTION

Pursuant to the provisions of the General Security and Public Order Act and the Berlin Disaster Response Act [Berliner Katastrophenschutzgesetz, BlnKatSG], the authority for supervisory and approval activities under atomic energy law which operates within the Senate Department for the Environment, Transport and Climate Protection ('Nuclear Supervisory Body') has primary responsibility for the disaster response plan for the area surrounding the research reactor.

In an emergency, the Senate Department for the Environment, Transport and Climate Protection assists the Berlin Fire Brigade in its joint operations management activities by supplying experts from the Nuclear Supervisory Body and the Supreme Radiation Protection Authority.

The Senate Department for the Environment, Transport and Climate Protection also sends a representative to the Federal State's Supreme Crisis Unit (Central Operations Management [Zentrale Einsatzleitung, ZELtg] within the Senate Department for Interior Affairs and Sport).

The Federal State's radiological situation centre operates within the SMS, which is accordingly responsible for producing and updating the radiological survey. It does so in close cooperation with the Radiation Protection Department at the Helmholtz Centre Berlin. The radiological situation centre at the Berlin Radiation Monitoring Station also assists the Berlin Fire Brigade in coordinating the monitoring activities of the CBRN exploration vehicles and ensures that the latest monitoring data from the reactor remote monitoring system are available at all times in the operations rooms of the Fire Brigade and the Senate Department for Interior Affairs and Sport.

9.2 ALARMS AND STAFFING OF THE RADIOLOGICAL SITUATION CENTRE

The Berlin Fire Brigade initially raises the alarm with the situation centre for disaster response at the SMS. Subsequent alarms for additional bodies and organisations are raised by the on-call team according to the internal plans and on the basis of a list of telephone numbers which is updated on an ongoing basis. If necessary, the Berlin Police Force provides additional staff for the situation centre. The measures taken to ensure that systems are operational and that other bodies are notified include the following:

- Establishment of telephone and data communications
- Activation of the hardware and software available for emergencies
- Establishment of contact with the expert on oversight under atomic energy law and with the radiation protection unit at the Helmholtz Centre Berlin
- Establishment of contact with the Federal Office for Radiation Protection's central unit for JRodos and ELAN
- Establishment of contact with the German Meteorological Service
- Notification of the water withdrawal point Beelitzhof Waterworks located in the relevant area
- Readiness for operation of the SMS monitoring vehicle

9.3 PROVISION OF UP-TO-DATE INFORMATION FOR SITUATION ASSESSMENTS

The situation centre is supplied with the latest data by the Helmholtz Centre Berlin on a continuous basis. The reactor remote monitoring system within the MKT software can also be used to supplement these data.

The latest weather data are forwarded by the Helmholtz Centre Berlin and can be supplemented by means of information from the reactor remote monitoring system. Weather information requested directly from the DWD is used as the situation progresses. Data from the DWD (with weather forecasts) can also be accessed within JRodos.

9.4 HAZARD ZONES

The area surrounding the reactor is divided into different zones (500, 4000, 8000 and 20 000 meter circles) in order to allow the preparation of specific measures. Deployment areas are identified by dividing the middle, outer and long-distance zones into 12 sectors of 30° each and numbering them in a clockwise direction, with Sector 1 lying symmetrically to the north.

9.5 FORECASTING OF THE RADIOLOGICAL SITUATION

The tools available for forecasting the radiological situation include the software programs Safer and JRodos, which simulate the anticipated dispersion of radionuclides as a basis for determining whether public protection measures should be recommended.

JRodos is the Federal Government's official emergency planning tool and is now also used by several other national emergency response centres in Europe (a sample forecast calculation can be seen in Figure 28). Its use is therefore also mandatory within the Federal State of Berlin. As a precautionary measure, however, recommended measures are initially identified on the basis of the transmitted data by means of forecast calculations carried out using the software program Safer, which is a much faster procedure. In order to calculate the forecasts as quickly as possible, the source terms are estimated for predefined scenarios and the associated emissions data are stored both in Safer and in JRodos.

The radiological survey, together with all the information relevant to the situation, is forwarded on a continuous basis not only to the units operating in the Federal State of Berlin, but also to the emergency planning department of the Federal Government.

After 24 hours, more in-depth and therefore larger scale situation assessments are carried out if necessary by the BMUB on the basis of JRodos calculations.

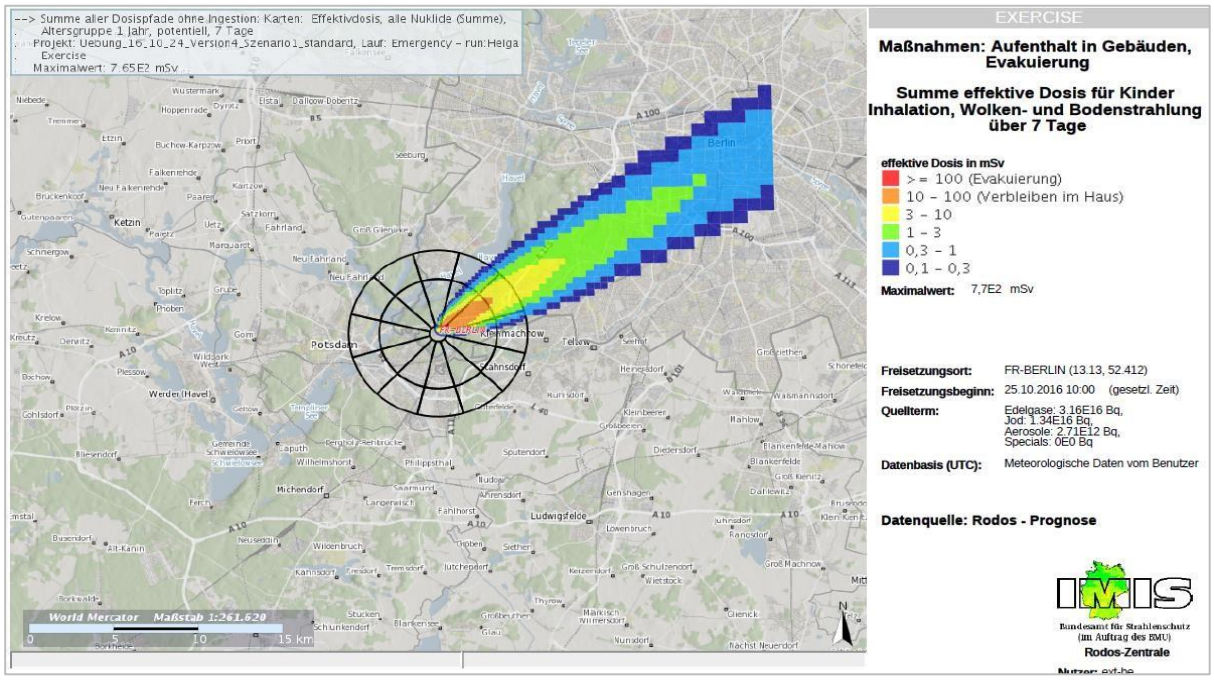


Figure 28. Forecast calculation carried out using JRodos (English translation below)

DE	EN
Summe aller Dosispfade ohne Ingestion: Karten: Effektivdosis, alle Nuklide (Summe), Altersgruppe 1 Jahr, potentiell, 7 Tage Projekt: Uebung_16_10_24_version4_Scenario1_standard, Lauf: Emergency – run: Helga	Total of all dose pathways without ingestion: Maps: Effective dose, all nuclides (total), Age group one year, potential, seven days Project: exercise_16_10_24_version4_Scenario1_standard, run: Emergency run: Helga

Exercise Maximalwert: 7.65 E2 mSv	Exercise Maximum value: 7.65 E2 mSv
Exercise	Exercise
Maßnahmen: Aufenthalt in Gebäuden, Evakuierung	Measures: Remain indoors, evacuation
Summe effektive Dosis für Kinder Inhalation, Wolken- und Bodenstrahlung über 7 Tage	Total effective dose for children Inhalation, cloud and ground radiation over seven days
effektive Dosis in mSv	Effective dose in mSv
>= 100 (Evakuierung)	>= 100 (evacuation)
10-100 (Verbleiben im Haus)	10-100 (remain indoors)
Maximalwert: 7,7E2 mSv	Maximum value: 7.7E2 mSv
Freisetzungsort: FR-BERLIN (13.13, 52.412)	Release location: FR-BERLIN (13.13, 52.412)
Freisetzungsbeginn: 25.10.2016 10.00 (gesetzl. Zeit)	Start of release: 25.10.2016 10.00 (legal time)
Quellterm: Edelgase: 3.16E16 Bq, Jod: 1.34E12 Bq, Aerosole: 2.71E12 Bq, Specials 0E0 Bq	Source term: Noble gases: 3.16E16 Bq, iodine: 1.34E12 Bq, aerosols: 2.71E12 Bq, Specials 0E0 Bq
Datenbasis (UTC): meteorologische Daten vom Benutzer	Data pool (UTC): meteorological data from user
Datenquelle: Rodos-Prognose	Source of data: Rodos forecast

10 VERIFICATIONS

10.1 INTRODUCTION

Verification activities were limited to a representative sample of the monitoring networks and the associated laboratories as outlined in the verification programme (Annex 1) and detailed below. At the opening meeting at the Berlin Radiation Monitoring Station (SMS), which is commissioned by the State authority, presentations were given by:

- **Berlin Radiation Monitoring Station** on the legal framework and monitoring systems in place within the State of Berlin
- F**ederal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety** detailing the German structure for radiation protection and their central role
- **Federal Office for Radiation Protection** on their role in the environmental monitoring programme for Berlin
- **Senate Department for the Environment, Transport and Climate Protection** on their participation in the environmental monitoring programme for Berlin
- **Senate Department for Justice, Consumer Protection and Anti-Discrimination** on their responsibility for radiation prevention planning
- **Criminal Investigation Department of the Berlin Police** on measurements undertaken in the event of a radiological incident
- **Berlin Fire Brigade** on measurements in case of a radiological event and their leadership of the operational and tactical operations
- **Senate Department for Health, Long-Term Care and Gender Equality** on the official control of radioactive substances in drinking water by the public health authorities in Berlin

10.2 BERLIN RADIATION MONITORING STATION

10.2.1 Crisis room

The Berlin Radiation Monitoring Station (SMS) has a crisis room, which is equipped primarily for a possible accident in the BER II reactor, but which can be used in all radiological situations affecting the city. The room has access to the BER II reactor control system, to the environment monitoring systems and to the national IMIS-system. In addition the centre has capability to carry out atmospheric dispersion modelling (SAFER 2 and JRODOS systems) and it can use the emergency service visualisation system GeoFES.

The centre is not permanently manned; alarms for the 24h stand-by duty personnel are transmitted via mobile phones.

10.2.2 Measurements and sampling

SMS is able to carry out a comprehensive programme of radiological monitoring. Measurements made at the SMS laboratory location are taken as the reference values for the Berlin research reactor sited at the Helmholtz Centre, about 20 km away. The following capabilities were demonstrated:

Deposition sampling

A Walther & Partner wet deposition (rain) sampler with a surface area of 1 m^2 is sited in an open area, though there are a number of trees some 5 m away. The sampler opens automatically when it rains.

Ambient dose monitoring

Three ambient dose sensors, each containing 2 phosphate glass dosimeter probes are hung from a wire stretched between 2 trees.

Air sampling

A medium volume air sampler incorporating active flow control is located within the main building. It draws air from outside at the rate of 60 m^3/h. The filter (25 cm) is changed weekly. In the event of an emergency the flow rate can be increased to 120 m^3/h. No charcoal filter is available for gaseous iodine monitoring (mobile systems are used for iodine monitoring).

The SMS monitoring vehicle is equipped with a mobile small-volume air sampler. This device has charcoal and particulate filters and a flow counter.

Soil sampling

SMS carries out soil sampling in which an area of 1 × 1 m is marked out on the lawn and the grass cut and placed in a plastic bag. A special tool consisting of a 10 cm high stainless steel cylinder welded to a base plate was placed on the cut grass. A hammer is then used to drive the sampler, located within the cylinder into the ground, thus ensuring that the top 10 cm of soil is sampled. In the laboratory the sample is sliced to 1 cm slices for gamma spectroscopy. Drying is performed until the sample weight remains constant.

In-situ gamma spectroscopy

A Canberra Inspector mobile gamma spectroscopy system (liquid nitrogen cooled HPGe detector) is available for monitoring ground contamination on 1 meter height. Typical counting time is 35 minutes. Spectra are sent to SMS for analysis. Efficiency calibration of the system is based on ^{152}Eu point source measurements.

Sample management

Following the physical sampling sample sheets are filled with data relating to the matrices sampled, (time, date, location, sampler's name, quantity etc.). In the SMS laboratory a separate room is allocated to the tasks of reception and initial preparation.

Verification team suggests removing the obstructing trees close to the atmospheric wet deposition sampler.

10.2.3 Laboratory

The laboratory of the SMS is well equipped for radiological monitoring. Typical samples include soil, sludge, food, feed, mixed diet, milk, fish, grass, cereals, several types of water, beverages, air filters, etc. The laboratory staff for alpha, beta, and gamma measurements consists of eight persons. Data is fed into the customised laboratory data system RaMIS and can be exported to the IMIS system.

SMS laboratory is accredited for all routine tasks and operates according to well-defined written procedures and an approved quality system. The laboratory participates in the annual intercomparison exercises organised by the IMIS coordinating laboratories.

Sample receipt, preparation and storage

Two persons are employed for routine sampling of various matrices (grass, soil, foodstuffs, mixed diet, etc.) insofar as the sampling is carried out by SMS. Other members of SMS will support if necessary. Upon arrival samples are first registered in the online RaMIS sample registration database before being directed to dedicated areas depending on whether they present low activity or potentially higher activity. Each sample receives a unique identifier (barcode). The sample receipt and preparation area (low activity) is equipped with 2 scales, one of which is calibrated by ”Landesamt für Mess- und Eichwesen” in accordance with the food sales regulations. Scales are controlled daily. A fridge and a freezer are used to store samples as appropriate. Three ovens and

three furnaces are used for drying/ashing samples as required. There are also a mixer and grinder available for sample preparation.

Samples received from the BER II reactor surroundings are kept for future reference; other environmental samples are discarded after analysis.

Radiochemistry laboratory

The SMS radiochemistry laboratory carries out the chemical preparations for alpha counting, beta counting (^{89}Sr-analysis, ^{90}Sr-analysis, and Tritium analysis) as well as gamma counting.

Counting equipment

All counting equipment of the SMS laboratory are labelled with the calibration date and its validity. The following equipment are available:

- Berthold 770 10-chamber low level alpha/beta analyser (2 chambers were not working with appropriate accuracy)
- Canberra Alpha analyst (4 chambers)
- 11 Canberra gamma spectrometers. Each system carries indications of the geometries for which it has been calibrated. Liquid nitrogen is used for detector cooling. Canberra Genie 2000 software and analogue electronics modules are used. A mixed radionuclide control standard from the PTB is measured monthly. The results are entered in the Genie 2000 control programme, which plots the calibration results in terms of efficiency, peak energy and system resolution (FWHM).
- PerkinElmer Tri-Carb 3170TR/SL liquid scintillation counter. SMS plans to acquire a second counter.
- PerkinElmer Analyst flame atomic absorption spectrophotometer (^{90}Sr analysis)

A UPS system is available for electrical back-up.

Measurement procedures

Short versions of the operating procedures for analyses are available beside each piece of equipment. If necessary the detailed versions could be consulted in the respective files, which are stored close by.

Data handling and reporting

Laboratory uses a customised data management system RaMIS for management of sample measurement data. All measurement results for IMIS and REI purposes are exported to the IMIS database. Upon receipt by IMIS the data is checked for conformity by the relevant coordinating laboratory. Monthly reports are typically made available on the SMS website 4 weeks after analysis has been performed. This data, which the public can access, can also be viewed in map mode, though the exact sample location is not revealed for reasons of confidentiality.

No remarks.

10.3 Berlin Office of the Federal Office for Radiation Protection

10.3.1 Automatic dose rate monitoring

The Federal Office for Radiation Protection (BfS) manages the data centre of the dose rate monitoring network in Berlin. Altogether there are six such centres ('Knoten') in Germany. The signals from the gamma dose rate stations located in the State are received every 10 minutes by LAN (e.g. from DWD stations), or every 6 hours by telephone. Each station has its own defined alarm threshold as there are considerable differences in the natural background levels throughout the country. The

telephone network is analogue, though this is set to be phased out in the coming years. Investigations are under way to define a suitable replacement, such as the mobile phone network.

Radiation monitoring stations do not collect weather data; this is received from the German Meteorological Service (DWD), which has statutory control of all such data. This data may differ from that which could be measured directly beside the monitoring stations but in Germany there is a legal restriction on gathering such data by third parties.

In-house experts work on the development of new detectors and the communication infrastructure. In addition to the detectors covering the national territory there are also a number of stations deployed at German Embassies abroad for the protection of diplomatic staff.

Verification team visited one of the dose rate monitoring devices (ODL-Sonde) at the Berlin Tempelhof airport. This detector is monitoring only dose rate. It has an excellent location on an open field at the fenced meteorological monitoring station of the DWD.

> *Verification team suggests, in the long term, giving further consideration to facilitating precipitation monitoring at the dose rate monitoring sites.*

10.3.2 Airborne monitoring

The Federal Republic of Germany has 4 helicopter based measurement systems which allow monitoring environmental radioactivity of large areas in a relatively short period of time. This offers an important tool for nuclear emergency management in case of accidental releases of radioactive material from a nuclear installation. The helicopters, operated by the German Federal Police, are based in Munich and Berlin. The latter, fully equipped was flown in and the on-board measurement devices were explained to the verification team.

The measurement equipment (Figure 29) consists of 4 NaI detectors (high sensitivity) and one HPGe detector (lower sensitivity but better resolution). The equipment is not permanently fitted but can be rapidly installed by trained crew members. In the event of a radioactive ground contamination (or lost radioactive source) in the environment the helicopter is used to locate 'hot spots', which are then surveyed by the ground measurement teams. The system can also be used to monitor suspected radioactive cargo in lorries or ships.

The German helicopter team regularly organises or takes part in European measurement campaigns. In the future it is hoped to develop unmanned craft for airborne detection which will be able to operate for more than 1 hour, which is currently the limit for such operations. In order to realize this, a scientific research program, organised by EURAMET[21] is being carried out.

[21] European Association of National Metrology Institutes (previously known as EUROMET) is a collaborative alliance of national metrological organizations from Member States of the European Union and of the European Free Trade Association (EFTA).

Figure 29. Radiation monitoring equipment installed in the Federal Police helicopter

10.3.3 Laboratories

The verification team visited the laboratories of the Federal Coordinating Office for drinking water, groundwater, wastewater, sludge, waste and wastewater of nuclear facilities at the BfS. The main task of this office is to provide state-of-the-art instructions regarding the sampling and sample preparation of water samples, their analyses and evaluation. These specified instructions serve for instance as guidance for the Federal State monitoring stations. In addition, the Federal state monitoring stations can check the quality of their radioanalytical analyses by attending one of the laboratory intercomparisons, organised by the Federal Coordinating office.

BfS operates a low background laboratory attenuated by a 1 m thick ceiling. The equipment consists of 5 HPGe detectors for gamma spectroscopy, two liquid scintillation counters (Packard Tricarb 3170 TR/SL and Quantulus), an alpha spectrometer (Canberra Alpha Analysts), a low-level spectroscopic alpha/beta counter (Berthold) and a grid-ionisation chamber (ORDELA).

No remarks.

10.4 Federal Institute of Hydrology water monitoring station in Berlin

The Federal Institute of Hydrology (BfG) is responsible for monitoring water flow rates and water quality on Germany's rivers. Since the mid-1950s they have also carried out measurements of radioactivity concentrations. Verification team visited the sampling station where radioactivity in the waters of the river Spree is measured on a site belonging to the Berlin police. The station is not manned on a continuous basis; a staff member typically visits every 2 weeks. If the situation warrants (emergency or above normal values) spot sampling can be performed by staff dispatched from the BfG headquarters in Koblenz.

No specific power backup is available but the Berlin police would have priority in the event of a power failure, ensuring that measurements could rapidly resume. The system includes an alarm for a no flow condition.

10.4.1 Early warning system

Continuous radioactivity measurement (early warning) is carried out using a Berthold detector (Figure 30). A small quantity of water is drawn from the river and analysed in real-time. Samples are

drawn from approximately 1.5 m below the surface and monitored for 10 minutes (NaI detector for total gamma). The alarms are received at the BfG headquarters.

Mussels and sediment cause problems and the system needs to be thoroughly cleaned every 6-12 months. Measurement results are generated every 10 minutes and the 1 hour integrated values are transmitted to the BfG headquarters.

Figure 30. On-line river water radioactivity monitor

10.4.2 Automatic water sampling

An automatic sampler (Figure 31) collects 50 ml of water every 30 minutes which is transferred to a 3 litre plastic bottle (no additives), which forms the daily 24h sample. In total the sampler can collect 36 of such daily samples which are subsequently transferred to the institute's laboratory in Koblenz for radioactivity analysis.

Figure 31. Automatic river water sampling system

10.4.3 Sediment sampling

In addition to the automatic samplers the verification team verified the equipment for collecting sediment samples (suspended matter) for a monthly radioactivity analysis.

No remarks.

10.5 Criminal Investigation Department of the Berlin Police and the Berlin Fire Brigade

Verification team visited the Criminal Investigation Department (CID) of the Berlin Police, where a joint display of some of the equipment available for emergency monitoring and other equipment was given to the team. Vehicles are also employed for routine measurements in order to ensure that the trained personnel maintain their capabilities.

Two comprehensively equipped vans (CBRN reconnaissance vehicle and ATF command vehicle) which can respond to CBRN incidents were demonstrated. Both have a number of fixed samplers for air sampling and hand held instruments (contamination detectors and dose rate monitors for field measurements, no nuclide identification capability). When searching for lost or stolen radioactive sources the data from the vans can be mapped and combined with other units' data in order to calculate the estimated location of the radiation source.

There are plans to install radioactivity monitoring equipment also on a police drone (Figure 32). The data of the drone are then forwarded to the coordinating office and also to the command vehicle of the CID – analogously to the CBRN reconnaissance vehicle. The data can also be transferred to and displayed in GeoFES.

There is no federal coordination of CBRN measurements, though a standard data file format is employed which allows transfer of data between States should the need arise.

No remarks.

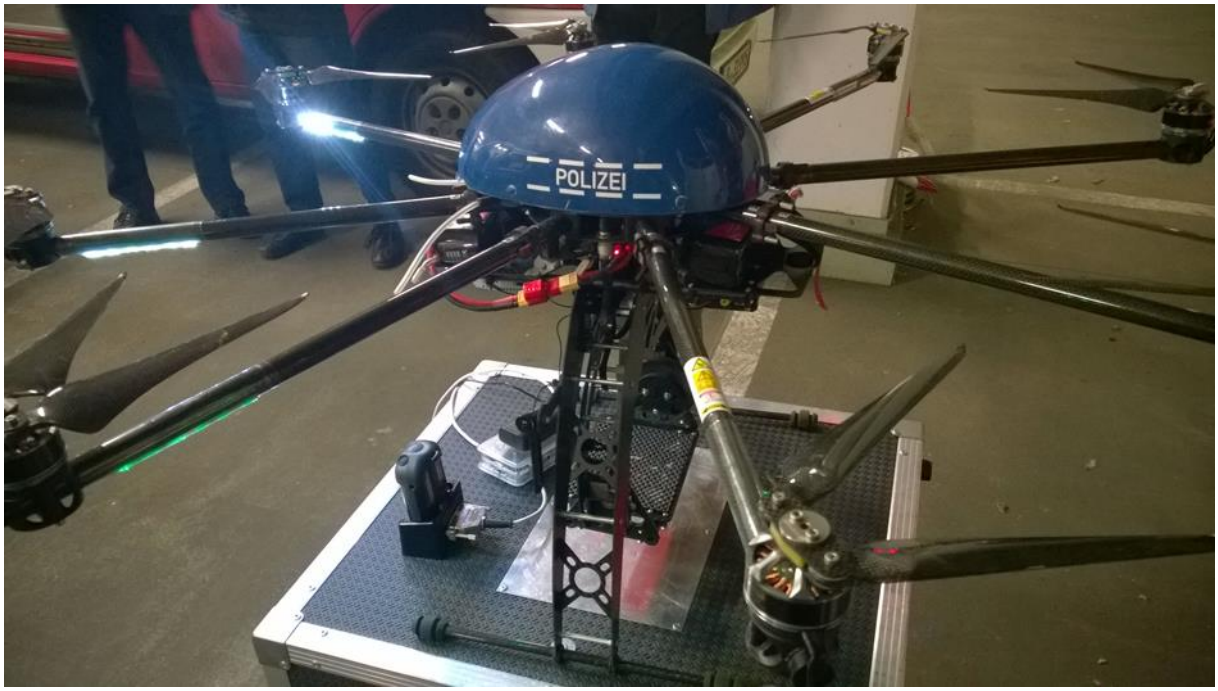


Figure 32. Police drone

10.6 HELMHOLTZ CENTRE BERLIN FOR MATERIALS AND ENERGY

This institute houses the BER II research reactor, which began operation in 1972 and reopened after renovation and approval in 1991. It will cease operation in December 2019 (decision of the HZB supervisory board). It is an open, light water moderated swimming pool reactor generating 10 MW of thermal power. The reactor was not included in the verification. Nevertheless as it represents the most important possible radiological hazard in Berlin some elements of the routine and emergency monitoring carried out in the vicinity were demonstrated.

In particular one of the off-site gamma dose rate measurement stations, located at a height of 3 m on a lamp post in a residential street was seen. The station is equipped with a UHF sender for data (dose rate, temperature, battery status) transmission to the site emergency center.

The following on-site facilities were also verified:

- Air monitoring container including a Berthold step-filter air monitoring (alpha/beta) system and an charcoal cartridge for iodine monitoring (Figure 33)
- Dose rate monitor Berthold LB 10876500-3 (separate detectors for low and high dose rates)

- Precipitation collection system (sample analysis in the institute laboratory)
- Ambient dose monitor (TLD) on the site fence

Monitoring of liquid and gaseous discharges from BER II reactor were not included in the verification.

No remarks.

Figure 33. Air monitoring container at the Helmholtz Centre

10.7 German Meteorological Service in Potsdam

The DWD Potsdam weather station has 9 staff members, though in routine operation only one is present during the 8h day shift. The chief role is the nationwide measurement of radioactivity in air and precipitation in collaboration with the BfS. Many dose rate monitoring stations are located at the DWD weather stations.

On-site a gamma dose rate probe was seen, together with a wet/dry deposition collector. The collector consists of an enamel shower base. It is planned to replace this with a sampling unit containing a stainless steel funnel in the near future for automatic sampling of precipitation. As part of the routine monitoring programme radioactivity in precipitation is measured monthly, under normal conditions by gamma spectrometry and, after radiochemical preparation, for $^{89/90}$Sr, plutonium, uranium, americium and tritium.

A step filter is operated for aerosol collection. The measurement is carried out immediately during the sampling. A second step filter system performs measurements of artificial α- and artificial ß-activity. A charcoal filter is installed above this filter for gaseous iodine monitoring.

Additional equipment includes in-situ gamma spectroscopy, a sampling unit filled with molecular sieve for gaseous elementary and activated carbon for gaseous organic iodine, medium-volume air sampler, ^{14}C sampler and collection of noble gases for subsequent analysis by gas chromatography at the DWD headquarters in Offenbach.

Verification team supports the replacement of the wet/dry deposition collector by a stainless steel vessel.

11 CONCLUSIONS

All planned verification activities were completed successfully. The information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, proved very useful.

The information provided and the verification findings gave rise to the following observations:

(1) Overall, the environmental radioactivity monitoring programme in Berlin complies with the requirements of Article 35 of the Euratom Treaty.

(2) The verification activities found that the facilities needed to carry out continuous monitoring of levels of radioactivity in the air, water and soil in Berlin are adequate. The Commission ascertained that these facilities are in operation and running efficiently.

(3) The verification activities found that the facilities needed to carry out monitoring of levels of radioactivity in the air, water and soil in the event of a radiological emergency in Berlin are adequate. The Commission ascertained that these facilities are continuously available.

(4) A few suggestions for improvement have been formulated. These suggestions do not alter the fact that environmental monitoring is in line with the provisions set out in Article 35 of the Euratom Treaty.

(5) The team's recommendations are set out in the 'Main Conclusions' document addressed to the German competent authority through the German Permanent Representative to the European Union.

(6) The Commission services kindly request the German authorities to submit, before the end of 2020, a report on any significant changes in the set-up of the monitoring systems, in particular following the foreseen closure of the BER II reactor. Based on this report the Commission will consider the need for a follow-up verification.

(7) The verification team acknowledges the excellent cooperation it received from all people involved in the activities it undertook during its visit.

APPENDIX 1

VERIFICATION PROGRAMME

Date	Time		Participants
2 May	13.00-17.00	**Berlin Radiation Center (SMS)** Short presentations on the institutions involved and their tasks: - Federal authorities: BfS - SenUVK - SenJustVA - SenGPG/LAGeSo - LKA Berlin - Bln FW Visit the SMS	BMUB BfS SenUVK, SenJustVA, SenGPG LKA Berlin, Bln Fw
3 May	9.00-11.00	**BfS Karlshorst** - measuring point and network nodes in the location-based metering network of the federal government - tasks of a control centre in the IMIS monitoring system - airborne measurements	BfS
	11.30-12.30	**BfG measuring station** - measuring point for surface water	BfG
	14.00-17.00	Additional measuring capacities of the state of Berlin in the event of an emergency. Mobile radioactivity measuring systems - Landeskriminalamt Berlin - Berlin fire brigade System for data transmission, evaluation and analysis	LKA Berlin Bln Fw
4 May	9.00-12.00	**Laboratories in the SMS** - analysis of samples: soil, vegetation, - surface water, groundwater, - drinking water, food and feed (incl. milk, mixed diet) - sewage sludge and other residues - waste treatment plants, sediment and plankton - precise measurements for the sparse network - analysis of air and precipitation - sample acceptance and preparation - gamma measurement - measurement of beta-emitting isotopes - measurement of alpha-radiating isotopes - data evaluation, storage, retrieval and-transmission - quality management system - In-situ measurements	BMUB SenUVK
	13.30-14.00	**German Meteorological Service Potsdam** - Air measuring point	DWD
	14.00-14.30	**Helmholtz Centre Berlin** Gamma dose rate probe - local dose rate measurement - remote monitoring system of the research reactor	
	16.00-17.00	Closing meeting	

APPENDIX 2

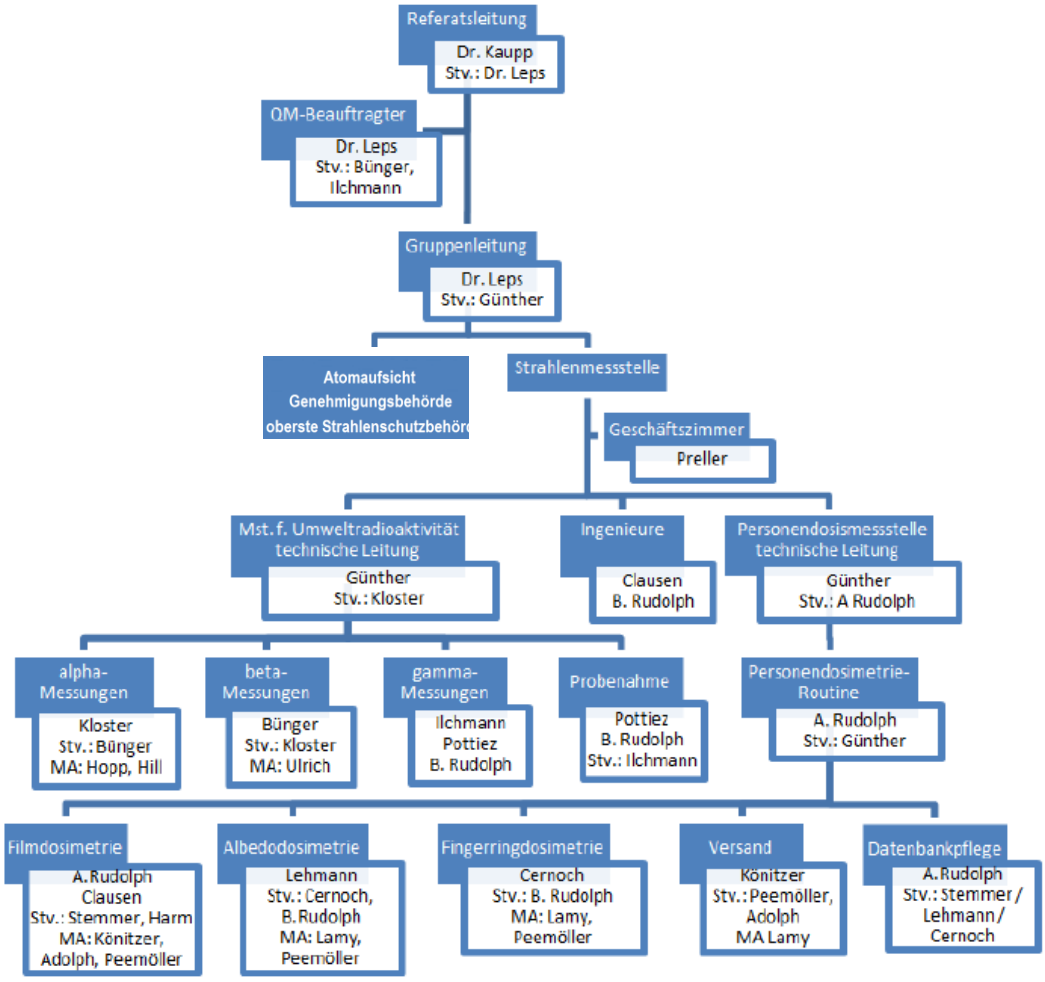
Competencies in relation to the monitoring of radioactivity in the environment in Berlin

Authority	Department	Competency
Senate Department for Interior Affairs and Sport	Department II A 'Fire Safety and Disaster Response'	Basic principles of emergency and disaster response; technical oversight over the Berlin Fire Brigade and Police
Subordinate to: **Berlin Fire Brigade**		Measurements in the event of an emergency; operational and tactical control in the event of a disaster
Subordinate to: **Police President of Berlin**		Measurements in the event of an emergency; assistance in the event of a disaster
Senate Department for the Environment, Transport and Climate Protection	Supreme radiation protection authority	Responsibility for precautionary radiation protection plans; expert
	Approval and supervisory authority under atomic energy law	Expert advice in an emergency; responsibility for the disaster response plan for the area surrounding the research reactor BER II
	Berlin Radiation Monitoring Station	Tasks relating to the monitoring of radioactivity in the environment and in the area surrounding the research reactor BER II; Federal State situation centre for radiological situations; dosimetric monitoring of emergency workers in an emergency
Subordinate to: **State Office for Occupational Safety, Health Protection and Technical Safety Berlin**	Radiation Protection Department	Enforcement tasks in the field of radiation protection
Senate Department for Health, Long-Term Care and Gender Equality		Provision of emergency hospital care for those suffering injuries following a radiation-related accident

Subordinate to: **State Office for Health and Social Affairs Berlin**		Monitoring of radioactivity in drinking water from the Berlin water treatment plants (central water treatment plants within the meaning of §3(2a) of the Drinking Water Ordinance 2001)
Senate Department for Justice, Consumer Protection and Anti-Discrimination	Consumer Protection Division	Monitoring of radioactivity in foodstuffs and feedstuffs
Assigns tasks to: **Berlin-Brandenburg Federal State Laboratory**		Testing of imported samples (except in an emergency)
Districts	Health authorities	Monitoring of water treatment plants pursuant to the Drinking Water Ordinance

APPENDIX 3

Organisational chart of the Berlin Radiation Monitoring Station



DE	EN
Stv., MA	deputy, employee
Referatsleitung	Head of the Division
Gruppenleitung	Head of the Group
Atomaufsicht Genehmigungsbehörde	Oversight under Atomic Energy Law Approval Authority
oberste Strahlenschutzbehörde	Highest Radiation Protection Authority
Strahlenmessstelle	Radiation Monitoring Station
Geschäftszimmer	office
Mst. f. Umweltradioaktivität technische Leitung	monitoring station for environmental radioactivity Technical Director
Ingenieure	engineers
Personendosismessstelle technische Leitung	monitoring station for personal doses Technical Director
alpha-Messungen	alpha measurements

beta-Messungen	beta measurements
gamma-Messungen	gamma measurements
Probenahme	sampling
Personendosimetrie-Routine	personal dose monitoring - routine
Filmdosimetrie	film dosemetry
Albedodosimetrie	albedo dosemetry
Fingerringdosimetrie	finger ring dosemetry
Versand	shipping
Datenbankpflege	data base maintenance