EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

Directorate D - Nuclear Energy, Safety and ITER
D.3 – Radiation Protection and Nuclear Safety

Technical report of the verifications under the terms of Article 35 of the Euratom Treaty

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Luxembourg

National monitoring network for environmental radioactivity

15 & 16 October 2015

Reference: LU 15-04

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FACILITIES:	National monitoring network for environmental radioactivity
LOCATIONS:	Luxembourg city, Findel, Schengen, Esch-sur-Sûre, Remerschen and Burmerange
DATES:	15 & 16 October 2015
REFERENCE:	LU 15-04
TEAM MEMBERS:	Mr V. Tanner (team leader) Ms M. Marin-Ferrer Mr A. Ryan
REPORT DATE:	23 March 2016

SIGNATURES:

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TABLE OF CONTENTS

1 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the Basic Safety Standards[1]. Article 35 also gives the European Commission (EC) the right of access to such facilities in order that it may verify their operation and efficiency. The radiation protection and nuclear safety unit (ENER D.3) of the EC's Directorate-General for Energy (DG ENER) is responsible for undertaking these verifications. Directorate-General Joint Research Centre (DG JRC) provides technical support during the verification visits and the preparation of the reports.

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

- Liquid and airborne discharges of radioactivity into the environment by a site (and control thereof);
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways;
- Levels of environmental radioactivity on the territory of the Member State.

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

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The EC's decision to conduct an Article 35 verification was notified to the Government of Luxembourg by a letter addressed to the Luxembourg Permanent Representation to the European Union on 16/4/2015. The Government of Luxembourg subsequently designated the Department of Radiation Protection (DRP) to lead the preparations for this visit.

2.2 DOCUMENTS

In order to facilitate the work of the verification team, a questionnaire was sent by the EC and a package of information was supplied in advance by the national authorities. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1 to this report. The information thus provided has been extensively used for drawing up the descriptive sections of the report.

2.3 PROGRAMME OF THE VISIT

The EC and the DRP discussed and agreed upon a programme of verification activities, which is given in Appendix 2, with due respect to the Commission Communication of 4 July 2006 setting out practical arrangements for the conduct of Article 35 verification visits.

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1 Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (OJ L-159 of 29/06/1996) which will be superseded 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 of 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, p. 2–5).

The following representatives of the national authorities and other parties involved were met:

Department of Radiation Protection

Patrick Majerus	Head of Radiation Protection Department
Marielle Lecomte	Head of Radiological Analysis Services (SAR)
Patrick Breuskin	Head of Emergencies and Equipment Services
Michèle Pallmer	Engineer, Metrology (SAR)
Karin Pier	Laboratory assistant (SAR)
Sandra Wersand-Quell	Engineer (SAR)
Jose Coelho	Technician (Emergencies and Equipment Services)

3 RESPONSIBLE ORGANISATIONS

3.1 DEPARTMENT OF RADIATION PROTECTION

The legislative and executive competence in the field of radiation protection in Luxembourg is attributed to the Minister of Health. The law of 21 November 1980 concerning the organisation of the Directorate of Health defines a Department of Radiation Protection (DRP) and allocates particular missions to all departments within the Directorate of Health. Similar to a number of other small countries, the DRP centralises as a single department all radiation and nuclear safety competence. The organisational structure and tasks of the DRP are summarised in Figure 1.

The DRP is at the technical level in charge of preparation of draft texts for laws, regulations and decrees. These drafts are then submitted to the department of legal affairs of the Ministry of Health for coordination of the legislative procedure. The DRP also defines the conditions for licenses for the users of radioactive materials. It has further issued several guidelines on radiation protection.

The DRP is currently composed of 9 experts with a master degree or PhD, specialised in radiation protection (1), medical physics (2), nuclear physics and engineering (2), physics (1), geology (1), biology (1) and chemistry (1). The permanent staff of the DRP is further composed of one Bachelor engineer, two technicians, a laboratory assistant and a secretary.

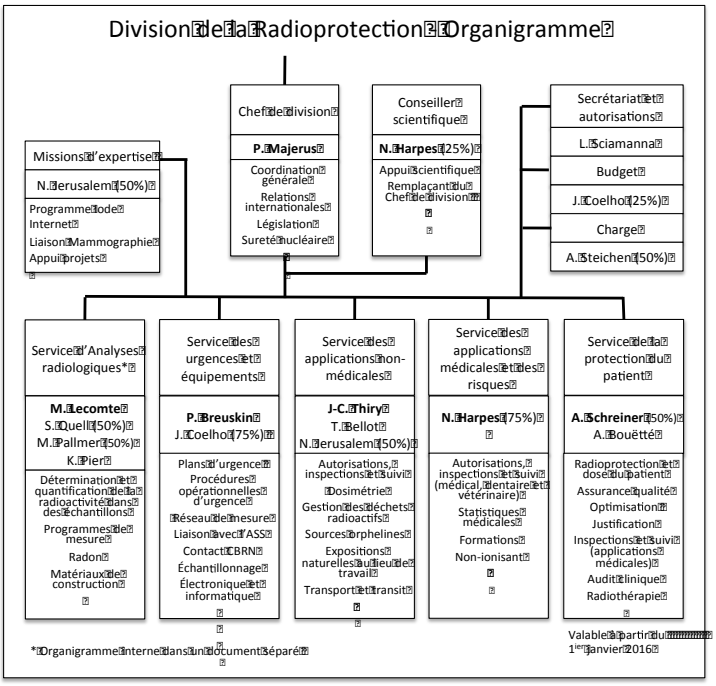

Figure 1. Organisational structure of the Department of Radiation Protection

4 LEGAL FRAMEWORK FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1 LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

Luxembourg does not operate any nuclear reactors or fuel cycle installations. The main use of ionising radiation in the country is for medical purposes with some applications in industry, construction and research. Luxembourg has introduced a legal framework, which is in line with the EU radiation protection legislation and the IAEA standards for ionising radiation control. Luxembourg has also created the necessary basic administrative structure for monitoring of environmental radioactivity throughout the country.

The regulatory framework for ionising radiation control in Luxembourg, including monitoring activities, is the following:

- Law of 25 March 1963 concerning the protection of the population against the dangers arising from ionizing radiation.
- Law of 21 November 1980 concerning the organization of the Directorate of Health.
- Grand-ducal regulation of 14 December 2000 concerning the protection of the population against the dangers arising from ionizing radiation.

4.2 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

In addition to the national legal framework, Luxembourg follows the international regulations below:

European Union

- Council Decision 87/600/Euratom of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency
- 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 and subsequent 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

- 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
- Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption
- Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of health of the general public with regard to radioactive substances in water intended for human consumption
- Directive 2008/56/EC of 17 June 2008 establishing a framework for community action in the field of marine policy (Marine Strategy Framework Directive)
- Commission Recommendation of 20 December 2001 on the protection of the public against exposure to radon in drinking water supplies

5 ENVIRONMENTAL RADIOACTIVITY MONITORING IN LUXEMBOURG

5.1 INTRODUCTION

There are three nuclear reactor sites within 100 km of the Luxembourg borders (Tihange in Belgium, Chooz and Cattenom in France). In no other EU country an active nuclear power plant is located closer to the national capital than here. Due to the proximity of the Cattenom nuclear power plant in France (10 km from the French-Luxembourgish border, 25 km from the Luxembourg City), the environmental radioactivity monitoring is focussed on the south of Luxembourg, where the majority of the population also lives. The programme includes monitoring of radiation dose rate, radioactivity concentration in air and radioactivity in atmospheric deposition, surface and drinking water, soil and food. The programme establishes a baseline for evaluation of the impact of any radiological incident or emergency affecting the territory of Luxembourg. The programme is managed solely by the DRP. Annex 3 provides a more detailed overview of the programme.

Based on a bilateral agreement between the French and Luxembourgish Governments the national authorities from France and Luxembourg have set up a protocol for exchanging of all relevant information during a nuclear emergency. An identical protocol has been set up with Belgium. With Germany there is no specific arrangement, except one between Civil Protection Services for Cooperation and Information exchange in a case of any emergency with transboundary effects, including radiological and nuclear emergencies.

5.2 MONITORING NETWORK DATA CENTRE

The radiation monitoring network data centre is located at the DRP headquarters in the Villa Louvigny, Luxembourg City. This system is permanently linked with a fully operational back up system sited at the Administration des services de secours in Gasperich. The data centre receives data from both fixed and mobile radiological monitoring systems and from the national meteorological centre "Météo Lux" of the l'Administration de la navigation aérienne. By combining this data with data received from neighbouring countries and meteorological data, DRP can evaluate dispersion of radioactive material during an emergency situation and support the other Luxembourgish authorities in initiating protective measures. By combination of meteorological data and monitoring stations data, DRP can determine when the alarm is due to the increased concentration of radionuclides.

The data centre has UPS power back-up providing 45-60 minutes autonomy, which is backed up by an emergency diesel generator for long-term operation without external power. The data centre network interconnections are presented in Figure 2.

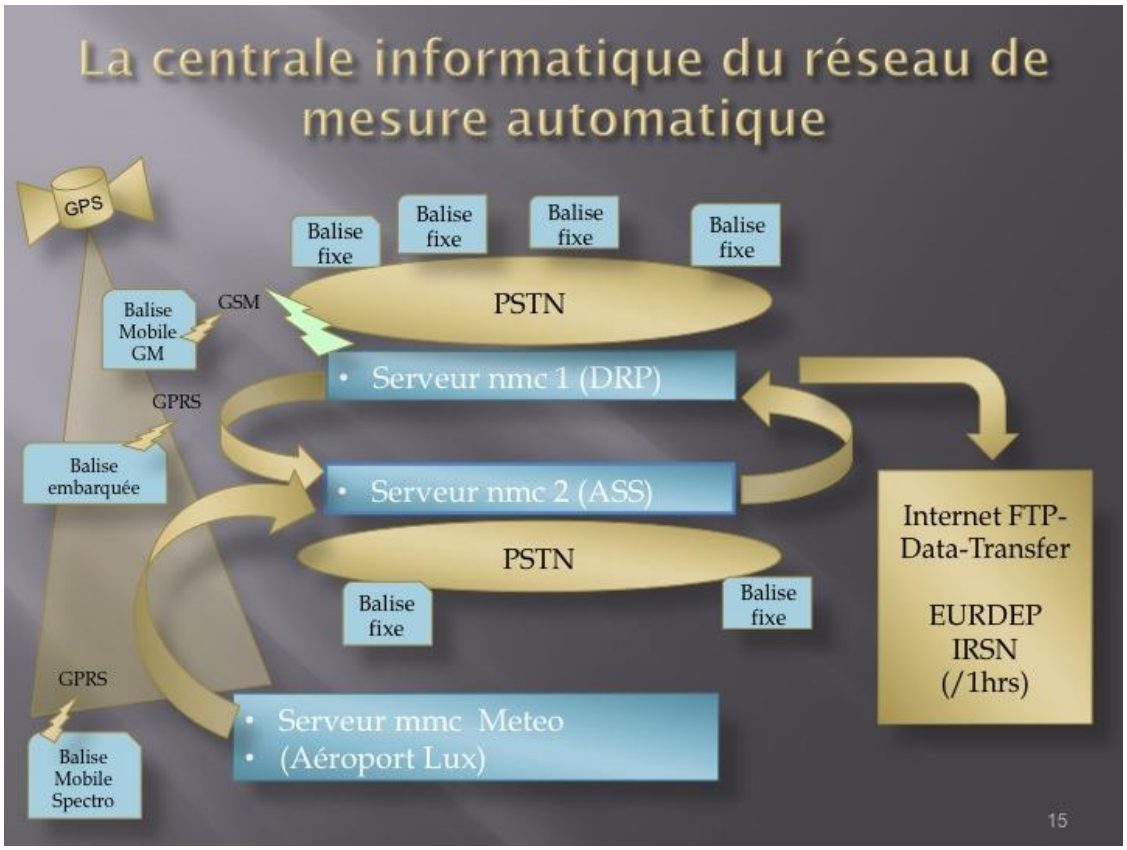

Figure 2. Overview of the interconnections of the national datacenter network

5.3 MONITORING OF EXTERNAL GAMMA DOSE RATE

The external gamma dose rate monitoring network consists of 18 fixed monitoring stations (Geiger-Mueller LB9111 Berthold) and 1 fixed Gammaspectral (NaI SARA 711F Envinet) station. Locations of the stations are presented in Figure 3.

The network sends data automatically to the EURDEP platform every hour. Long-term averages of environmental radioactivity measurement results are sent to the EC's Radioactivity Environmental Monitoring (REM) databank (Article 36 of the Euratom Treaty) on an annual basis.

DRP staff visit each network station on a regular basis. No outside contractors are involved in the network management or maintenance.

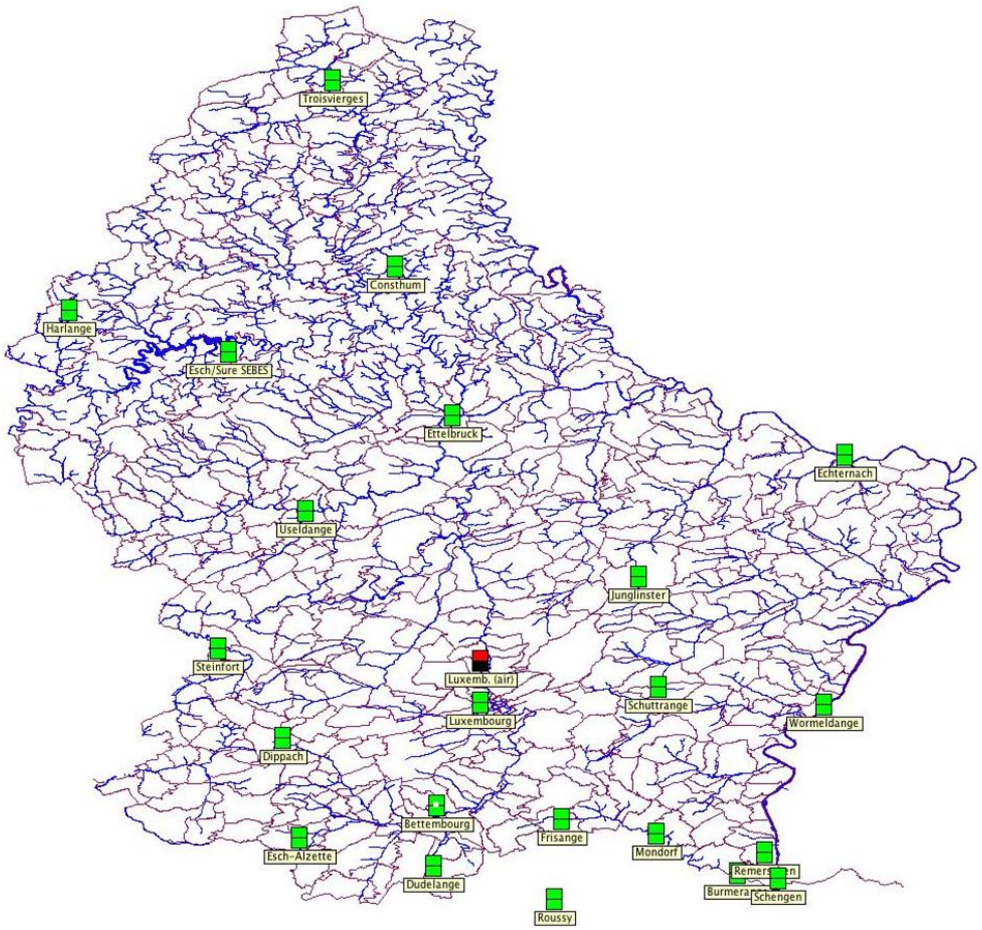

Figure 3. On-line ambient radiation monitoring network in Luxembourg

5.4 MONITORING OF RADIOACTIVITY CONCENTRATION IN AIR

Monitoring of radioactivity concentration in air is carried out by filtering large volumes of air and measuring the radioactivity of the material collected on the filters. For this purpose Luxembourg has 3 on-line air sampler devices and 2 off-line.

- 1 on-line low volume air sampler (25 m^3/h) DGi9100 located in Roussy, France[3]
- 1 off-line low volume air sampler (60 m^3/h) DGi9100 located in Luxembourg city
- 1 off-line high volume air sampler (800 m^3/h) ASS 500 located at Findel airport
- 2 Low volume air samplers (40 m^3/h) Berthold LB-DR 150 with detection equipment (α/β, radon), integrated in the online network, located in Luxembourg City and Burmerange

Locations of the on-line devices are presented in Figure 4. The air filters of Findel airport and Luxemburg-City are changed every week, Burmerange every two weeks; then they are analysed at the SAR laboratory. The samplers in Burmerange and Luxembourg City are equipped with alpha/beta detectors and therefore provide also on-line data every hour. The sampler in Roussy, France, has also an alpha/beta detector and an in-situ gamma spectrometer. The station is located only about 5 km from the Cattenom NPP between the plant and the Luxembourg border. This sampler is ideally located to provide early warning to Luxembourg in the event of a radioactive release from Cattenom.

[3] During the verification the measuring station located at Roussy (France) was under replacement. The team was informed that it will again be operational by end of the year 2016.

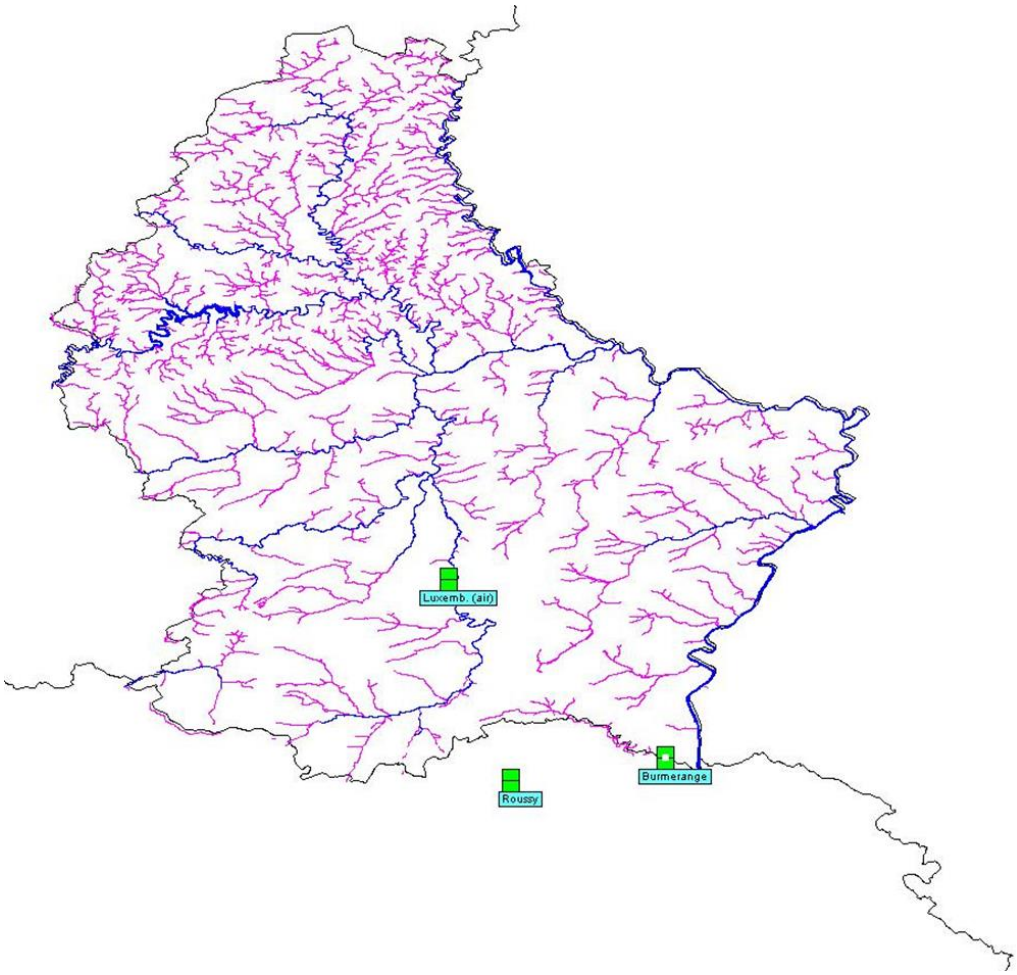

Figure 4. On-line aerosol sampler locations

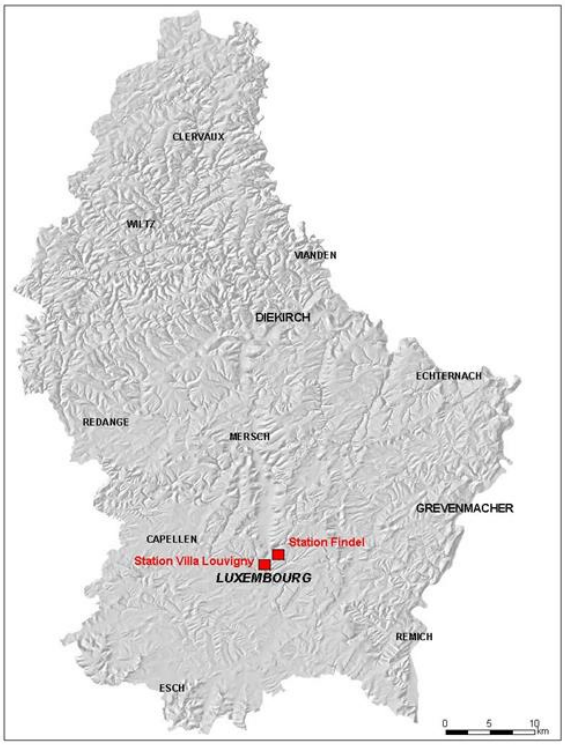

Figure 5. Off-line aerosol sampler locations

5.5 MONITORING OF RADIOACTIVITY CONCENTRATION IN DRY AND WET DEPOSITION

Monitoring of radioactivity in dry and wet atmospheric deposition is done by collecting precipitation samples at the Villa Louvigny and Findel airport (Figure 6). Samples are measured in the SAR laboratory (tritium, ^{7}Be, ^{134}Cs, ^{137}Cs, ^{131}I and total alpha/beta). The sample from the Villa Louvigny is analysed only if there are abnormalities in the Findel sample. The high volume collection device has a collection area of 40×40 cm. Sampling period is one week.

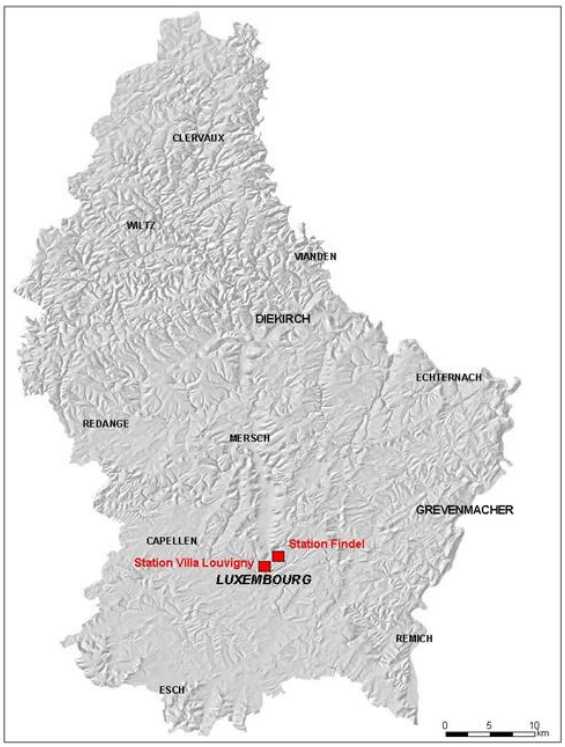

Figure 6. Dry/wet deposition monitoring locations

5.6 MONITORING OF RADIOACTIVITY CONCENTRATION IN SURFACE AND DRINKING WATER

Monitoring of radioactivity concentration in water is done by collecting water samples and measuring the radioactivity content (^{40}K, ^{134}Cs, ^{137}Cs, ^{131}I, tritium and total alpha/beta in surface water and tritium and total alpha/beta in ground and drinking water) of these samples in the SAR laboratory. Samples are collected from surface water and drinking water at several locations throughout the country. Particular attention is given to the river Moselle, large water purification facilities and large commercial users of water (breweries and one bottled water producer). Figure 7 presents the sampling sites of commercial users and main drinking water suppliers. A complete list of sampling sites is presented in Annex 4.

With regard to the monitoring of drinking water, the producers are responsible to control radioactivity according to the Council Directive 2013/51/Euratom. The SAR has offered since 2000 the measurements for free to these producers.

In two critical locations at Schengen (Moselle River downstream from Cattenom NPP) and Esch-sur-Sûre (raw water supply of the SEBES water purification facility) water sampling is automated and complemented with an on-line NaI detector for early warning. Both automated monitoring stations are part of the national radiological surveying network and managed by the national monitoring data centre.

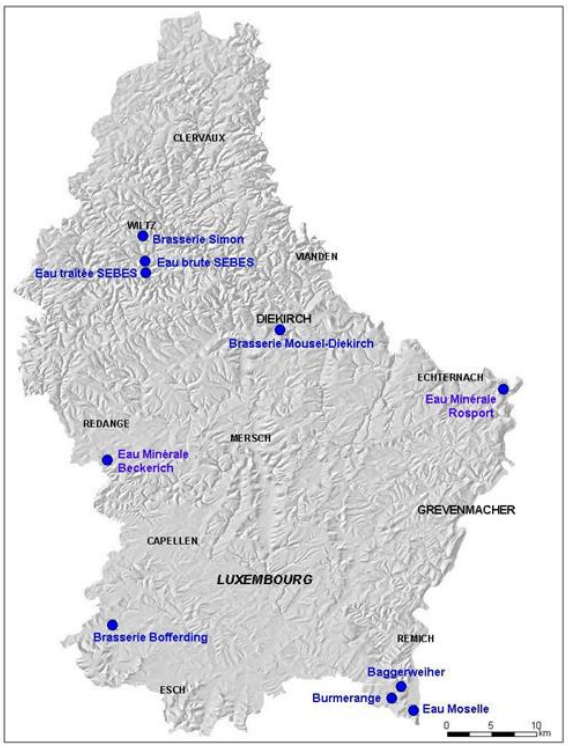

Figure 7. Surface and drinking water sampling locations

5.7 MONITORING OF RADIOACTIVITY CONCENTRATION IN FOOD

Monitoring of radioactivity in food is carried out by measuring samples of milk, foodstuffs and mixed diet in the SAR laboratory.

5.7.1 Milk

Milk is sampled at four locations (1 dairy and 3 farms) presented in Fig. 8. Monthly sample volume is 5 litres. Each sample is measured by gamma spectroscopy (^{40}K, ^{134}Cs, ^{137}Cs, ^{131}I). In addition the samples collected at Burmerange are measured for tritium and total-beta.

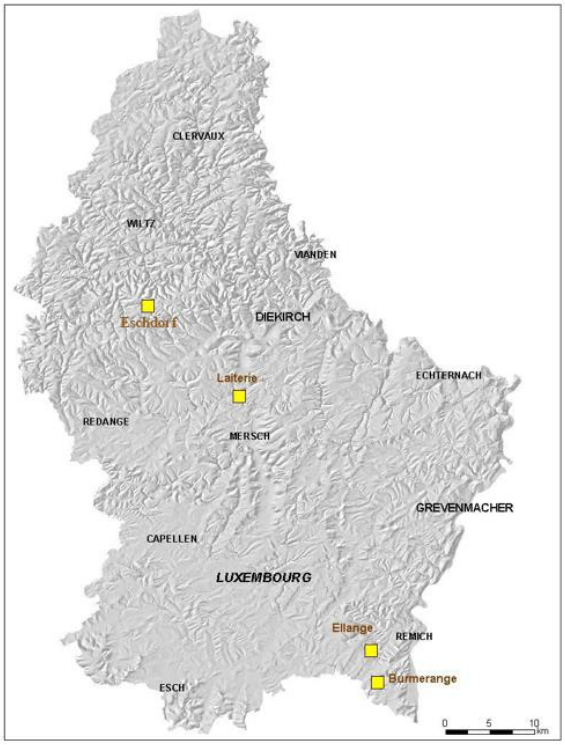

Figure 8. Milk sampling locations

5.7.2 Foodstuffs

Foodstuff monitoring includes vegetables, fruit, meat (beef, pork), eggs, mushrooms, wine and game originating from Luxembourg. Sampling is carried out on a monthly basis or depending on the season. Samples are analysed for ^{40}K, ^{134}Cs, ^{137}Cs and ^{131}I at the SAR laboratory.

5.7.3 Mixed diet

Mixed diet is sampled at the Luxembourg central hospital canteen. Sampling includes three meals for one day once a month. Samples are measured at the SAR laboratory by gamma spectroscopy (^{40}K, ^{134}Cs, ^{137}Cs, ^{131}I).

5.8 OTHER ELEMENTS OF THE PROGRAMME

Monitoring of air, water and food is complemented by including also soil, sediments, feeding stuffs, biota and flora in the regular monitoring programme. In addition the programme includes preparedness to carry out mobile radiation measurements.

5.8.1 Soil and sediments

Soil and Moselle river sediments are sampled monthly at one location close to Schengen (Fig. 9). Samples are transported to the SAR laboratory for analysis on the same day.

Soil sample is a 20×20 cm sample of max. 7 cm depth. The sample is analysed (gamma spectroscopy and beta counting) at the SAR laboratory for ^{40}K, ^{134}Cs, ^{137}Cs and total beta.

The sediment sample is collected at the dam on the river Moselle at Schengen. The sample is analysed (gamma spectroscopy and beta counting) at the SAR laboratory for ^{40}K, ^{134}Cs, ^{137}Cs, ^{131}I, ^{58}Co, ^{60}Co, ^{110m}Ag, ^{54}Mn and total beta.

Figure 9. Soil and sediment sampling location

5.8.2 Feeding stuffs

Feeding stuffs are sampled at the Mersch agricultural centre. Samples are measured at the SAR laboratory by gamma spectroscopy (^{40}K, ^{134}Cs, ^{137}Cs).

5.8.3 Terrestrial and aquatic biota and flora

The following seasonal samples are taken for analysis of radioactivity (^{40}K, ^{134}Cs, ^{137}Cs) in terrestrial and aquatic biota and flora:

- Grass once a year in May-June;
- Blackberries at Schengen;
- Mushrooms;
- Fish from river Moselle once a year.

Analysis of these samples is carried out at the SAR laboratory.

5.8.4 Mobile monitoring

In order to quickly survey the radiological situation during an emergency situation, DRP has mobile monitoring systems, which can be quickly transported to the places of interest. These systems comprise five Envinet AGS 421 and four Envinet MIRA stations, which measure radiation dose rate and precipitation. The systems have built-in power supply (Battery and solar panels), GPS and wireless communications for autonomous operation. In addition the DPR has two car-borne systems, one comprising a dose rate monitor (Envinet MobRAD) and one a spectroscopic detection system (Envinet MONA) coupled to a GPS-location system for geographical data mapping.

The environmental radiation monitoring programme in Luxembourg does not include capability to carry out airborne measurements. However, in case of an emergency DPR has an arrangement with neighbouring countries to carry out cross-border airborne monitoring on Luxembourgish territory.

6 LABORATORIES PARTICIPATING IN THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

6.1 DRP SERVICE D'ANALYSES RADIOLOGIQUES

6.1.1 Introduction

The SAR laboratory is located at the DRP headquarters in the Villa Louvigny in the centre of Luxembourg city. The laboratory is the only environmental radioactivity laboratory in Luxembourg; it analyses all the samples collected within the national monitoring programme. The laboratory is fairly small – staff consists of only 4 persons. Currently no external analysis services are used, but the option is available should a need arise. The laboratory is accredited according to ISO/CEI 17025:2005. Internal laboratory procedures updated in June 2015 are available.

6.1.2 Sample registration and preparation

Samples are collected by the DRP emergency preparedness staff or by the facility providing the sample. Each sample is registered in the laboratory database and given a unique identifier number. In the event of an emergency, incoming (possibly contaminated) samples would be sorted before bringing them inside the laboratory.

The SAR laboratory has the necessary equipment for storing (refrigerators and freezers), preparing (dryers, furnaces) and weighting the samples (scales). In line with the accreditation, calibration of the measuring equipment is carried out by an external calibration service.

6.1.3 Measurement devices

SAR laboratory counting room is temperature-controlled and equipped with oxygen and methane monitors. It houses the gamma, gross alpha/beta, LSC and alpha spectroscopy systems. The measurement devices have UPS-systems for electrical back-up. Each measurement system has a written work instruction and a weekly control sheet for recording routine control measurements.

Gamma spectroscopy

Four Canberra HPGe gamma spectroscopy systems using digital electronics and Genie2000 software are available with relative efficiencies ranging from 33% (1 detector) up to 60% (3 detectors). Calibration of the systems is done yearly using commercial standards. Weekly quality control of these systems involves efficiency, energy and resolution (FWHM) stability controls.

Alpha spectroscopy

A Canberra AlphaAnalyst spectrometer was originally planned for drinking water measurements. However, this system has not been implemented for that purpose and it is currently not in use mainly due to the lack of staff to deal with the additional number of measurements.

Gross alpha/Beta proportional counter

A low-level Berthold LB770 counter is used for gross alpha/beta measurements. This equipment is specifically used for drinking water screening measurements. A low-level Berthold LB761 counter is used for delayed gross beta measurements on air filters originating from the online aerosol measuring stations.

Liquid Scintillation Counter

A low-level liquid scintillation counter HIDEX3005L is available for analysing tritium, alpha and beta in drinking water and milk.

6.1.4 Data handling and reporting

About 1000 environment samples are analysed in the laboratory annually. The laboratory has built its own database using Excel and Visual Basic for sample measurements management.

DRP publishes monthly reports on the website www.sante.lu containing the results of the monitoring measurements with a maximum delay of 60 days.

6.1.5 Quality management

In line with the accreditation, the SAR laboratory participates in laboratory intercomparison exercises (IAEA ALMERA, JRC IRMM, etc.).

7 VERIFICATIONS

7.1 INTRODUCTION

All verifications were carried out according to the agreed verification programme (Annex 2). The programme focussed on the monitoring of water and on the emergency monitoring arrangements.

7.2 ROUTINE MONITORING PROGRAMME

The verification team was shown the siting of the automatic monitoring systems and the overall sampling arrangements. DRP is responsible for the network management and also carries out the sampling.

The team noted that currently the radiation dose rate data is not available on a Luxemburgish public website, although it is made available on an hourly basis at the EU website (EURDEP).

> *Continuous public availability of environmental radiation dose rate information is an important element of radiological emergency preparedness arrangements in every country. The verification team recommends that DRP makes the on-line radiation dose rate data available on its public website.*

7.3 SAR ANALYTICAL LABORATORY

The verification team verified the SAR analytical laboratory at the Villa Louvigny. The laboratory is adequately equipped and well maintained, but the verification team would like to point out the following:

- The laboratory database is well suited for the routine environment programme, but its design would make it too heavy and slow in an emergency situation where the number of incoming samples increases significantly. SAR has already acknowledged this and is in process of developing a simple and robust system for maintaining sample control in an emergency situation.

  > *Verification team supports the development of the laboratory emergency sample and data control procedures.*

- SAR laboratory does not carry out ^{90}Sr measurements as it has no capability to carry out the required radiochemical separation.

  > *The verification team recommends that SAR considers acquiring the expertise and equipment to also carry out* ^{90}Sr *analysis.*

- SAR laboratory has a sufficient number of gamma spectroscopy systems, but only one instrument for gross-beta, gross-alpha/beta and liquid scintillation counting. The verification

team was informed that the laboratory has agreements with IRE and SCK/CEN in Belgium to provide analysis back-up in the event of malfunction of any of these instruments.

The verification team supports maintaining the equipment back-up arrangements with other laboratories. If the number of samples increases, the laboratory throughput should be increased by acquiring additional analytical equipment.

- The number of staff (4 trained persons) at the SAR laboratory is sufficient for a routine programme, but in the event of an emergency the demand for environmental analysis services would very quickly become overwhelming.

The verification team recommends that DRP considers options for ensuring the availability of sufficient qualified staff in an emergency situation.

7.4 ON-LINE AND OFF-LINE PERMANENT MEASUREMENT STATIONS

7.4.1 External ambient radiation dose rate network

The external gamma dose rate monitoring network in Luxembourg covers the country very well, but it is based on rather old detectors and analogue electronics. The verification team was informed that DRP has plans to initiate modernisation of the whole network within the next years.

Luxembourg City

The verification team verified the operation of the LB9111 radiation dose rate monitoring system on the roof of the Villa Louvigny in the centre of Luxembourg City. This station has one GM tube for low and another one for high dose rate situations.

Remerschen

The operation of the Envinet SARA gamma spectroscopy station located at the renewable energy demonstration site in Remerschen was verified.

Verification does not give rise to recommendations. The verification team supports the intention to modernise the network in the near future.

7.4.2 Monitoring of radioactivity concentration in air

Luxembourg City

On the roof of the Villa Louvigny in the centre of Luxembourg City the verification team verified the operation of the EG&G medium-volume air sampler AMS50 and the Berthold LB-DR150 low volume air monitor. The filters of these samplers are changed and analysed in the SAR laboratory weekly.

AMS50 air flow is controlled by a calibrated air flow monitor. Typically the flow through the filter is about 60 m^3/h. Total air flow is recorded for each filter.

The Berthold LB-DR150 is equipped with a calibrated air flow meter and on-line detectors for early warning of increased air radioactivity concentration. There is a UPS-system for the electronics, but not for the pump.

Findel airport

At the Findel airport the verification team verified the operation of the EG&G ASS-500 high-volume air sampler. The airflow through the filter is about 750 m^3/h. The station is equipped with an air flow

monitor and a filter heating system to avoid condensation of humidity on the filter. Total air flow is recorded for each filter.

Burmerange

The operation of the automatic medium-volume air radioactivity monitoring system located in the village of Burmerange, some 10 km from Cattenom NPP was verified. The system consists of an online LB Berthold alpha/beta monitor located on top of the filter and a filter for collecting a particulate radioactivity sample from the airflow. The system airflow is about 40 m^3/h. Filter change interval is two weeks. The total airflow passed through the filter is determined with a calibrated total flow counter and recorded for each filter. The system electronics unit has local UPS power backup and modem for data communication.

DRP informed of plans to relocate this monitoring equipment to the renewable energy demonstration site in Remerschen, where one Envinet SARA station is currently placed. The representativeness of this new location is considered better in the event of an atmospheric release from Cattenom.

Verification does not give rise to remarks.

7.4.3 Monitoring of radioactivity concentration in water

Water sampling is carried out at several locations throughout the country. Verifications were carried out in the most critical locations where the sampling is automated and complemented with on-line monitors.

Surface water monitoring at Schengen

The verification team verified the water monitoring arrangements at the river Moselle dam in Schengen, located about 10 km downstream from Cattenom NPP.

Automatic sampling system

The automatic water sampling system takes a 50 ml sample every 30 minutes. These samples are collected in bottles each representing 24h water flow. The samples are transported every 15 days to the SAR laboratory for analysis. The system has a UPS for electrical back-up.

On-line monitoring

In order to provide early warning of a possible radioactive release from Cattenom NPP to the river Moselle, there is a continuous monitoring system based on two NaI-detectors (3.5 meters below the nominal water surface) and a Berthold Micrologger BAI 9111-W data system. The system has UPS-back-up and a modem for data communication.

Drinking water monitoring at Esch-sur-Sûre lake

The water sampling arrangements at the SEBES water treatment facility were verified. The facility provides about 40% of the drinking water in Luxembourg. It uses the Esch-sur-Sûre reservoir as its raw water supply. This is the only surface water used for drinking water in Luxembourg. Radiological monitoring is carried out before treatment of the water, which allows a 24h margin between monitoring and distribution of the water to consumers.

Automatic sampling system

The automatic water sampling system takes a 50 ml sample every 30 minutes. These samples are collected in bottles (2.4 litre sample) each representing 24h plant inlet water flow. Bottles are collected at 15 day intervals and transported to the SAR laboratory for analysis. After the analysis the bottles are cleaned with acid. The system has a 1-2 hour UPS for electrical back-up.

On-line monitoring

In order to provide early warning of a possible radioactive contamination of the raw water supply, there is a continuous monitoring system based on a lead shielded NaI-detector chamber and a Berthold Micrologger BAI 9125 data system. The system has 2-3 day UPS-backup and a modem for data communication. A ^{137}Cs test source is available, but not permanently present in the chamber. There is also a flow detection system, which provides an alarm if the water flow through system is abnormal. The alarm limit of the system is 5 Bq/l (Minimum detectable activity (MDA) is 0.5 Bq/l ^{137}Cs). There is a remote alarm to DRP and a local visual alarm for high activity. SAR checks the system operation at 15 day intervals.

In the past the system had experienced problems due to condensation (the water temperature is about 8˚C throughout the year). These problems have been corrected and the system operation is reliable now. System check is done twice per month, in coincidence with the collection of the samples. Maintenance is done once per year.

Verification does not give rise to remarks.

7.4.4 Monitoring of radioactivity concentration in atmospheric deposition

Findel airport

The verification team verified the two dry-wet deposition (precipitation) collectors located next to the air sampler at Findel airport. These collectors have each a collection area of 50×50 cm; a 2x5 l sample is collected for analysis at the SAR laboratory each month.

Verification does not give rise to remarks.

7.5 MOBILE AND EMERGENCY MONITORING SYSTEMS

The verification team saw the mobile systems placed on the roof of the Villa Louvigny and at Findel Airport. DPR demonstrated also the data interface to the systems and the use of the data to develop overview maps of the radiation situation in the event of a radiological emergency. The equipment is new and available for deployment in the event of an emergency.

It was noted that there are only two persons in the DRP who have the required expertise to use the mobile systems and handle the data produced by them. DRP has addressed this issue by using a high level of automation in the technical systems and by co-operating with the French authorities in radiological assessment. Despite this, the number of trained staff is not sufficient, since in an emergency situation the system should remain functional on a 24h basis.

The verification team recommends that DRP trains additional personnel to carry out mobile monitoring and data handling and makes long-term arrangements for maintaining this expertise.

8 CONCLUSIONS

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

The information provided and the verification findings lead to the following observations:

(1) In general, the national environmental radioactivity monitoring programme in Luxembourg is in compliance with the requirements of Article 35 of the Euratom Treaty.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(3) A few recommendations are formulated, in particular as regards the laboratory database, public availability of data and the monitoring arrangements during an emergency situation. The recommendations do not discredit the fact that environmental monitoring is in conformity with the provisions laid down in Article 35 of the Euratom Treaty.

(4) The recommendations are summarised in the ‘Main Conclusions' document that is addressed to the Luxembourg competent authority through the Luxembourg Permanent Representative to the European Union.

(5) The Commission services request a report on the implementation of the recommendations by the Luxembourg authorities and about any significant changes in the set-up of the monitoring systems before the end of 2017. Based on this report the Commission will consider the need for a follow-up verification in Luxembourg.

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

APPENDIX 1

References and documentation

1. Verification preliminary information questionnaire, DRP, September 2015.
2. Le Réseau Luxembourgeois de surveillance automatique de la radioactivité ambiante, presentation by DRP for preparation of the verification.

APPENDIX 2

Verification programme

EURATOM ARTICLE 35 VERIFICATION

LUXEMBOURG

Routine and emergency radioactivity monitoring arrangements

15-16 October 2015

Date	Time	Activities
Thursday 15 October	9.30 – 10.30	Opening meeting at the laboratory of the Service d'Analyses Radiologiques (Villa Louvigny, Allée Marconi L-2120 Luxembourg)
	10.30 – 12.00	Verification of the national environmental radioactivity monitoring network data centre
	13.30 – 17.00	Verification of the laboratory of the Service d'Analyses Radiologiques (analysis of environment samples, mixed diet, foodstuffs and drinking water) Verification of the emergency monitoring equipment Verification of air radioactivity concentration and precipitation monitoring facilities in Luxembourg city
Friday 16 October	9.00 – 16.30	Verification of measuring facilities of the monitoring network • dose rate stations in southern Luxembourg • high-volume air sampler station and precipitation sampling in Findel (Luxembourg airport) • automatic water sampling stations in Schengen (Moselle river) and Esch-sur-Sûre lake (drinking water) • other selected facilities

APPENDIX 3

Sampling locations for Luxembourg

Sampling location	GPS coordinates north	east	Category	Samples	nucléides requested	sent	network sparse	dense	Notes
Luxembourg, reference point	49.62803	6.1232	mixed diet	meals of a whole day from a hospital kitchen + 1 litre of tap water	^{90}Sr, ^{137}Cs	^{137}Cs, ^{134}Cs	x	x	the hospital lies 2,5km away from the reference point
				fruit, vegetables and cereals		^{137}Cs, ^{134}Cs			the crops come from around Luxembourg City
				meat		^{137}Cs, ^{134}Cs			beef and pork meat comes from different farms in Luxembourg, venison from Luxembourgish forrests
Luxembourg, Villa Louvigny	49.62803	6.1232	airborne particulates	air filter	^{7}Be, ^{137}Cs, gross beta	gross beta	x		The building where the DRP is located. It lies in the middle of Luxembourg City.
Luxembourg, airport Findel	49.62573	6.194158	airborne particulates	air filter	^{7}Be, ^{137}Cs, gross beta	^{7}Be, ^{137}Cs, ^{134}Cs ^{131}I	x	x	
				rain water		^{7}Be, ^{137}Cs, ^{134}Cs, ^{131}I, gross beta			
Burmerange (air filter)	49.48611	6.321853	airborne particulates	air filter	^{7}Be, ^{137}Cs, gross beta	gross beta	x		
Burmerange, farm	49.48736	6.321842	milk	whole cows milk	^{90}Sr, ^{137}Cs	^{137}Cs, ^{134}Cs, gross beta	x	x	
			milk	whey		^{3}H	x	x	
				eggs		^{137}Cs, ^{134}Cs			
Ellange, farm	49.51797	6.298153	milk	whole cows milk	^{90}Sr, ^{137}Cs	^{137}Cs, ^{134}Cs, gross beta	x		

Sampling location	GPS coordinates north	east	Category	Samples	nucléides requested	sent	network sparse	dense	Notes
Esch/Sauer (lake water)	49.90997	5.921761	surface water	drinking water as surface water reservoir		^{137}Cs, ^{134}Cs, ^{3}H, gross beta	x		Lac de Haute-sûre, artificial lake, largest drinking water reservoir of Luxembourg, samples taken at the lake
Esch/Sauer (drinking water)	49.90791	5.923853	drinking water	drinking water tap	^{3}H, ^{90}Sr, ^{137}Cs	^{3}H, gross beta	x	x	Lac de Haute-sûre, artificial lake, largest drinking water reservoir of Luxembourg, samples taken after processing at the tap
Eschdorf, farm	49.88223	5.933247	milk	whole cows milk	^{90}Sr, ^{137}Cs	^{137}Cs, ^{134}Cs, gross beta	x		
Insenborn, farm	49.89059	5.861289	milk	whole cows milk	^{90}Sr, ^{137}Cs	^{137}Cs, ^{134}Cs, gross beta	x		location no longer in use
Remerschen (lake water)	49.4974	6.360244	surface water	lake water not further specified		^{137}Cs, ^{134}Cs, ^{3}H, gross beta	x		artificial lakes next to the river Moselle, mainly ground water fed
Schengen (fish)	49.47167	6.367056		fish		^{137}Cs, ^{134}Cs			fished in the river Moselle
Schengen (Moselle water)	49.9005	6.366106	surface water	river water	^{137}Cs, residual beta	^{137}Cs, ^{134}Cs, ^{3}H, gross beta			river Moselle
Schengen (sediment)	49.91547	6.368708		sediment (river)		^{137}Cs, ^{134}Cs, ^{131}I, ^{110m}Ag, ^{54}Mn, ^{58}Co, ^{60}Co, gross beta			taken from the river Moselle
Schengen (soil)	49.46658	6.368275		soil currently unclassified		^{137}Cs, ^{134}Cs, gross beta			

APPENDIX 4

Ground water and drinking water (TW) sampling locations in Luxembourg

Origin	Commune	Source
Other		Ad. bâtiments publics Kuelbecherhaff
Other		Ad. bâtiments publics src Klaus
TW commercial users	Bascharage	Brasserie Bofferding, Bascharage
TW commercial users	Beckerich	Beckerich S.A.: source Melleschbour, source Roxane
TW commercial users	Diekirch	Brasserie Mousel Diekirch
TW commercial users	Echternach	Echternach, Hotel Bel Air
TW commercial users	Rosport	Sources Rosport S.A.: Blue PET, Viva PET
TW communes	Bech	Bech, Altrier, Geyershof, Hemstal, Hersberg-Altrier Forage 37, Hersberg-Altrier Forage 40, Rippig
TW communes	Bettendorf	Atelier, Cimetière Gilsdorf
TW communes	Bissen	Boevange, Moulin de Bissen
TW communes	Bous	Bous
TW communes	Consdorf	Forage Wolper, source Millewues
TW communes	Contern	source Milbech, source Stouwelsbësch
TW communes	Diekirch	Neubrunnen Stadion, station pompage puits-eau Dillingen, station pompage-eau puits terrain
TW communes	Echternach	réservoir Felsbuch mairie Echternach, réservoir Mélick centre de secours, réservoir Thoul Atelier
TW communes	Ell	forage 1, forage 2
TW communes	Ellange	Drosselschacht
TW communes	Erpeldange	puits Ingeldorf
TW communes	Esch/Alzette	forage Weisen 3, Jeunesse, source Wäschbour
TW communes	Ettelbruck	Campingswee, Grondwee 1983, source Dreiburen, Source Rollingen
TW communes	Fischbach	puits Debicht, puits Laangegronn
TW communes	Flaxweiler	source Lavoir

TW communes	Grevenmacher	Reservoir, Wiesenquelle, Geyershaff, Willibrordusquelle, Widderquelle, Seitenquelle, Waldquelle
TW communes	Junglinster	in den Haertgen, source Amber, source Kriipsweieren
TW communes	Larochette	puits Ouschterbuer, source Am Deich
TW communes	Lintgen	source Kasselt 1, source Kasselt 2, source Mouschelt, source Prettingen
TW communes	Luxembourg	Birelergrund, Dommeldange, Glasbouren, Kopstal, Mühlenbach, Pulvermühle
TW communes	Manternach	Quelle Bech
TW communes	Mompach	puits de Boursdorf, source de Geyershof, source de Girst
TW communes	Mondorf-les-Bains	réservoir Olbrecht, réservoir Stengenerbesch, réservoir Wouerbesch, Drosselschacht Ellange
TW communes	Niederanven	coll. Wasserwee (Hostert), source Rameldange
TW communes	Préizerdaul	réseau Bettborn, réseau Pratz
TW communes	Reisdorf	ancien puits, Bigelbach source Hanseschlaff, nouveau puits
TW communes	Sandweiler	complexe scolaire, Findel Business Center
TW communes	Schuttrange	Aal Quelle, Bohmillen Nei Quelle
TW communes	Steinsel	source Heisdorf
TW communes	Strassen	Source Brameschbierg 1, Source Brameschbierg 2
TW communes	Tandel	Tandel, REC Dall
TW communes	Vianden	réservoir Moalsbach, réservoir Sanatorium
TW communes	Waldbillig	Collecteur 1/2, Haerbur 1, Schiessentuempel 1+2, Siewebach, source Haerebur
TW communes	Wincrange	Hachiville, Hoffelt, Troine
TW DEA	Useldange	Béik, Bréimchen, Ribbefeld, Roubricht, Useldange
TW SEBES	Esch/Sûre	factory SEBES: Esch/Sûre, Everlange, Scheidhof, Trois-Ponts
TW SER	Kaulen	réservoir Kaulen-entrée forage Waldbredimus, réservoir Kaulen-entrée src Milbech
TW SES	Dondelange	Dondelange Pumpstation, Greisch, Pumpstation Koerich
TW SIDERE	Wormeldange	Kakeschboesch, rés. Kaulen, Waldbredimus, Schaedchen, Widdebierg