EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear energy, safety and ITER
D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

THE UNITED KINGDOM

Sellafield nuclear site

Emergency radioactivity monitoring arrangements
Monitoring of radioactivity in drinking water
Recent advances in monitoring aerial discharges

22-24 November 2017

Reference: UK 17-04

VERIFICATION UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Emergency radioactivity monitoring arrangements at the Sellafield site Monitoring of radioactivity in drinking water in the Sellafield site vicinity Recent advances in monitoring aerial discharges from the Sellafield site
LOCATIONS:	Sellafield; Warrington
DATES:	22-24 November 2017
REFERENCE:	UK 17-04
TEAM MEMBERS:	Mr V. Tanner (team leader) Ms K. Peedo
REPORT DATE:	19 March 2018
SIGNATURES:	

V. Tanner

K. Peedo

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ANNEXES

ABBREVIATIONS

Allerdale BC	Allerdale Borough Council
BAT	Best Available Techniques
BEIS	Department for Business, Energy & Industrial Strategy
DEFRA	Department for Environment, Food & Rural Affairs
DERL	Derived Emergency Reference Level
DMV	District Monitoring Vehicle
DWI	Drinking Water Inspectorate
CBC	Copeland Borough Council
CCCRU	Cumbria County Council Resilience Unit
CEAR	Compilation of Environment Agency Requirements
CFIL	Council Food Intervention Level
CN	Cavendish Nuclear Limited
EA	Environment Agency
EC	European Commission
ERL	Emergency Reference Level
EU	European Union
FSA	Food Standards Agency
HVAS	High-Volume Air Samplers
IAEA	International Atomic Energy Agency
LED	Light-Emitting Diode
LGC	LGC Limited
NEA	Nuclear Energy Agency
OECD	Organisation for Economic Co-operation and Development
ONR	Office for Nuclear Regulation
SAV	Separation Area Ventilation
SECC	Site Emergency Control Centre
SEMPS	Site Emergency Monitoring System
SL	Sellafield Limited
SPMS	Site Perimeter Monitoring System
TLD	Thermoluminescent dosimeter
UKRep	United Kingdom Permanent Representation to the European Union
UU	United Utilities Water Limited

TECHNICAL REPORT

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 the basic safety standards[1]. Article 35 also gives the European Commission (EC) 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 exposure 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 the United Kingdom of its decision to conduct an Article 35 verification in a letter addressed to the United Kingdom Permanent Representation (UKRep) to the European Union (EU). The United Kingdom Government subsequently designated the Department of Business, Energy & Industrial Strategy (BEIS) 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.

The Sellafield site has been subject to an Article 35 verification previously in 2004[4], 2010[5] and 2011[6]. These missions have addressed both environment and discharge monitoring issues, although with different verification target facilities.

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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 29.6.1996) and 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).

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 3 November 2017.

2.3 PROGRAMME OF THE VISIT

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

Due to verification team flight cancellations on 22 November 2017, the opening meeting of the verification had to be cancelled. The following presentations had been prepared and were provided to the verification team:

- Implementation of Euratom Directive 2013/51 in England (Mr. Marsden, DWI)
- Sources of drinking water (Dr. Allott, EA)
- Drinking water sampling and monitoring arrangements at Sellafield (Ms. Greggain, SL)
- Private water supplies: Monitoring (Ms. O'Reilly, CBC)
- Effluents monitoring: General framework (Dr. Allott, EA)
- Separation Area Ventilation (SAV) aerial discharge monitoring (Mr. Webley, SL)
- Effluents monitoring: Independent arrangements (Dr. Allott, EA)
- National emergency preparedness, response and recovery policy (Ms. Fallon, BEIS)
- Sellafield emergency monitoring arrangements (Mr. Stevens, SL)
- Environmental Thermoluminescent Dosimeters (TLD) at Sellafield (Mr. Desmond, SL)
- Food Standards Agency: Role and actions (Mr. Thomas, FSA)
- Emergency monitoring role and responsibility (Dr. Allott, EA)
- Emergency monitoring arrangements (Ms. O'Reilly, CBC)

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. The following representatives of the national authorities and other parties were involved in the verifications:

<u>Opening meeting at EA, Penrith</u>

Dr. Allott	Sellafield Regulation Manager, Environment Agency
Mr. Chambers	Safety and Resilience Manager, Allerdale Borough Council
Mr. Desmond	Environmental Monitoring and Assessments Manager, Sellafield Limited
Ms. Fallon	Head of International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Ms. Greggain	Infrastructure Environmental Advisor, Sellafield Limited
Mr. Kershaw	Emergency Planning Advisor, Cumbria County Council
Mr. Makinson	Nuclear Safety Inspector and Sellafield Site Infrastructure Inspector, Office for Nuclear Regulation
Mr. Marsden	Principal Inspector, Drinking Water Inspectorate
Ms. O’Reilly	Environmental Health Manager, Copeland Borough Council
Mr. Thomas	Senior Radiological Safety Officer, Radiological and Novel Foods Policy Team, Food Standards Agency
Ms. Robinson	Policy Advisor for International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy

[4] Art. 35 Technical report – UK 04/01, Installations for monitoring and controlling radioactive discharges and for surveillance of the environment in Cumbria during normal operations of the Sellafield site, 2005.

[5] Art. 35 Technical report – UK 10/05, Installations for monitoring and controlling radioactive discharges and for on-site surveillance of the environment during normal operations of the Sellafield Nuclear Fuel Reprocessing Plant, 2010.

[6] Art. 35 Technical report – UK 11/07, Installations for off-site surveillance of the environment during normal operations of the Sellafield Nuclear Fuel Reprocessing Plant and installations for monitoring and controlling liquid radioactive effluent discharges from the Lillyhall Very Low Level Radioactive Landfill Site, 2011.

Mr. Stevens	Emergency Management Environmental Specialist, Sellafield Limited
Mr. Thomas	Senior Radiological Safety Officer, Radiological and Novel Foods Policy Team, Food Standards Agency
Ms. Tideswell	Emergency Planning Officer, Cumbria County Council
Mr. Webley	Environmental Advisor and SAV Stack Coordinator, Sellafield Limited
Mr. Wilson	Head of Housing and Health, Allerdale Borough Council

Sellafield Site Visit

Dr. Allott	Sellafield Regulation Manager, Environment Agency
Mr. Desmond	Environmental Monitoring and Assessments Manager, Sellafield Limited
Ms. Fallon	Head of International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Mr. Makinson	Nuclear Safety Inspector and Sellafield Site Infrastructure Inspector, Office for Nuclear Regulation
Ms. Robinson	Policy Advisor for International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Mr. McCourt	Radiometric Systems Engineer, Sellafield Limited
Mr. Moore	Health Physics Technical Support, Sellafield Limited

Egremont Boreholes Visit

Dr. Allott	Sellafield Regulation Manager, Environment Agency
Ms. Fallon	Head of International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Mr. Halford-Maw	Water Quality Regulatory Manager, United Utilities Water Limited
Ms. Robinson	Policy Advisor for International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy

United Utilities Laboratory Visit

Ms. Fallon	Head of International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Ms. Robinson	Policy Advisor for International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Ms. Rowe	Nuclear Assessor for Reactor Assessment and Radiological Monitoring Team, Environment Agency

Closing meeting at United Utilities, Warrington

Dr. Allott	Sellafield Regulation Manager, Environment Agency
Mr. Chambers	Safety and Resilience Manager, Allerdale Borough Council
Ms. Fallon	Head of International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Mr. Halford-Maw	Water Quality Regulatory Manager, United Utilities Water Limited
Ms. Robinson	Policy Advisor for International Policy for Nuclear Safety and Radioactive Waste Management, Department for Business, Energy & Industrial Strategy
Ms. Rowe	Nuclear Assessor for Reactor Assessment and Radiological Monitoring Team, Environment Agency
Mr. Wilson	Head of Housing and Health, Allerdale Borough Council

3 BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING AT THE SELLAFIELD SITE AND IN ITS VICINITY

3.1 INTRODUCTION

The United Kingdom is a union between England, Northern Ireland, Scotland and Wales. When the term ‘UK Government’ is used in this document it refers to the Government at Westminster, responsible for all matters relating to England and for those matters where powers of decision-making have not been given to the administrations of Northern Ireland, Scotland or Wales. These matters are known as ‘reserved’ as they are taken by the UK Parliament at Westminster even though they have effect in Northern Ireland, Scotland and Wales as well as in England. Examples of reserved matters include nuclear security and nuclear safety.

Conversely some matters are 'devolved' as decision-making is the responsibility of the Scottish Parliament, the Welsh Assembly and the Northern Ireland Assembly, rather than the Government at Westminster. Examples of devolved matters include the environment. As some matters are devolved, this can create the potential for some differences in the way that certain regulations are enacted in law. Examples include the Environmental Permit Regulations 2016 (England and Wales) and the Radioactive Substances Act 1993 (Scotland and Northern Ireland) in regard to environmental permitting.

The UK Government represents England, Northern Ireland, Scotland and Wales in international fora acting as the responsible overall authority, including at the EU, EURATOM, United Nation (UN)’s International Atomic Energy Agency (IAEA), and the Organisation for Economic Co-operation and Development (OECD)’s Nuclear Energy Agency (NEA).

3.2 DEPARTMENT FOR ENVIRONMENT, FOOD & RURAL AFFAIRS

The Department for Environment, Food & Rural Affairs (DEFRA) is the UK Government department responsible for safeguarding natural environment, supporting food and farming industry and sustaining a thriving rural economy. DEFRA is a ministerial department, supported by 33 agencies and public bodies. It is the overall responsible authority in the UK for radiological surveillance of food.

3.3 DEPARTMENT OF BUSINESS, ENERGY & INDUSTRIAL STRATEGY

The Department for Business, Energy & Industrial Strategy (BEIS) brings together responsibilities for business, industrial strategy, science, innovation, energy, and climate change. It is responsible for developing industrial strategy and leading the UK Government’s relationship with business, ensuring that the UK has secure energy supplies that are reliable, affordable and clean, ensuring that the UK remains at the leading edge of science, research and innovation and tackling climate change. BEIS is the overall responsible authority in the UK for environmental radioactivity monitoring and nuclear and radiological emergency preparedness.

3.4 DRINKING WATER INSPECTORATE

The Drinking Water Inspectorate (DWI) was formed in 1990 to provide independent reassurance that public water supplies in England and Wales are safe and drinking water quality is acceptable to consumers. The organisation has 41 staff, all based in London. The DWI is the competent authority for ensuring the Euratom Drinking Water Directive[7] requirements are met in England and Wales. It provides independent reassurance that public water supplies in England and Wales are safe and

[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 of 7.11.2013)

drinking water quality is acceptable to consumers. The DWI also has a statutory role to act as a technical advisor to local authorities in relation to the implementation of the Private Water Supplies Regulations. This includes the provision of technical and scientific advice on all aspects of drinking water quality, including on private water supplies.

The DWI's main job is to check that the water companies in England and Wales supply safe drinking water that is acceptable to consumers and meets the standards set down in law. Inspectors independently test and audit water company laboratories. If any tests fail the standards then the inspectors use their powers to require the water company to make the necessary improvements to drinking water quality. When irregularities are found, the DWI investigates the operational incident and provides an independent report of the cause with recommendations on how to prevent similar events from happening again. If a water company fails to resolve a drinking water quality complaint then the consumer can come to the DWI for help.

3.5 ENVIRONMENT AGENCY

The Environment Agency (EA) is a non-departmental public body, established in 1995 and sponsored by the DEFRA, with responsibilities relating to the protection and enhancement of the environment in England. It employs around 11,200 staff in the UK. It is organised into eight directorates that report to the Chief Executive.

The EA's stated purpose is to protect or enhance the environment, taken as a whole, so as to promote the objective of achieving sustainable development. Protection of the environment relates to threats such as flood and pollution.

The Environmental Permitting (England and Wales) Regulations of 2016 provide the framework for controlling generation and disposal of solid, liquid and gaseous radioactive waste so as to protect the public and the environment. In particular, these regulations require prior permitting for the disposal or discharge of radioactive waste to the environment. Responsibility for granting a radioactive substances activity permit rests with the EA. This permit along with a separate Compilation of Environment Agency Requirements (CEAR) specifies conditions on operators.

The EA requires operators with significant radioactive waste discharges to undertake monitoring of the environment around their sites. The radioactivity substances activity permit requires operators to define, document and carry out an environmental monitoring programme. The operators are required to use Best Available Techniques (BAT) when taking samples and conducting measurements.

The EA also commissions independent monitoring of radioactive waste discharges and monitoring of the environment. This provides a check on the adequacy and the results of the operator monitoring programmes. The EA is responsible for independent radiological monitoring of non-food pathways and effluent monitoring. The EA carries out the following routine monitoring programmes:

- monitoring of the environment, primarily in the vicinity of nuclear sites;
- monitoring of drinking water sources in England and Wales (on behalf of DEFRA to fulfil Euratom Article 35 and 36 requirements and Council Directive 2013/51/Euratom);
- monitoring of effluent samples provided by nuclear site operators;
- monitoring of air and rainwater in the United Kingdom (on behalf of DEFRA to fulfil Article 35 and 36 requirements); and
- checking of waste quality of low-level radioactive waste disposals.

The EA also has an ad-hoc reactive monitoring programme that is available to undertake sampling and monitoring in support of specific investigations.

3.6 FOOD STANDARDS AGENCY

The Food Standards Agency (FSA) is responsible for food and feed safety and food hygiene in England, Wales and Northern Ireland. It works with local authorities to enforce food safety regulations and its staff work in UK food processing plants to check that the standards are being met.

The FSA commissions independent radiological monitoring of food. This provides a check on the adequacy and the results of the operator monitoring programmes. The FSA carries out the following routine radioactivity monitoring programmes:

- aquatic foods (including fish, shellfish and edible aquatic plants), primarily in the vicinity of nuclear sites;
- terrestrial foods (including milk, fruits, vegetables, cereals and animal products), primarily in the vicinity of nuclear sites;
- milk from diaries remote from nuclear sites (to fulfil Euratom Article 35 and 36 requirements);
- general diet in the form of representative canteen meals remote from nuclear sites (to fulfil Euratom Article 35 and 36 requirements).

The FSA also includes the provision for ad-hoc reactive monitoring as a requirement of the routine monitoring contracts. This provision is available to reallocate existing resources or request additional resource to undertake sampling and monitoring in support of specific investigations.

3.7 COPELAND BOROUGH COUNCIL

The Copeland Borough Council (CBC) is the designated regulator for private water supplies within the Borough boundary. The Private Water Supplies Regulations place a duty on local authorities to conduct a risk assessment of each private water supply within their area and to undertake monitoring in order to determine compliance with drinking water standards.

The local authority has powers under the Regulations to require that a supply is improved by the relevant person(s) who control the supply. The Regulations also require local authorities to provide private water supply monitoring data to the DWI.

4 RECENT ADVANCES IN THE MONITORING OF AERIAL DISCHARGES AT THE SELLAFIELD SITE

4.1 GENERAL

4.1.1 Site description

The Sellafield site (54°N-3°W) is located on the West Cumbria coastal plain adjacent to the Irish Sea. Ireland is the nearest EU Member State, the shortest distance from the site to the Irish border is about 180 km across the Irish Sea; the nearest major conurbation in Ireland is Dublin at a distance of 210 km and with a population of some 1 273 000 inhabitants.

The elevation of the Sellafield site ranges from 48 m AOD (inland side) to 9 m AOD (seaward side).

The Irish Sea exchanges water with the Celtic Sea (south) and with the Scottish Waters (north). The general flow pattern is northward. The estimated turnover time of the Irish Sea lies between one and three years. Meteorological forcing may however reduce transit times from Sellafield to the Scottish Waters to less than three months. The maximum tidal range varies between 3.3 and 8.4 m and the tidal currents between 0.26 and 0.82 m/s (the latter are parallel to the coast).

The wind speed and frequency distributions have a characteristic peak in SE winds (some 24% of occurrences from the 105°-165° sectors) and a broad dominance of SW to NW winds (some 38% of occurrences evenly spread over the 195°-315° sectors). Northerly to easterly winds are much less frequent and lighter. Strong winds (>7 m/s, 9.7% of occurrences) are principally from the 195°-315° sectors. Light winds (<1 m/s, 9.8% of occurrences) are evenly distributed over the wind rose. Strong winds are more frequent during the winter period. The mean wind speed over the period under scrutiny amounts to 4.35 ± 0.27 m/s.

Precipitation is predominantly associated with winds from the SW to NW sectors. The annual mean of precipitation is 1094 ± 174 mm with monthly maxima varying between ca. 90 mm (April) and ca. 260 mm (October) and monthly minima varying between ca. 10 mm (August) and ca. 60 mm (November). The period between March and April is the driest in the year; the wettest is between October and November.

The countryside around Sellafield is mainly utilised for farming: within a 15 km radius, arable land cowers 6% of the area and grasslands 94%. The main crops are spring barley, oats, turnips and swedes (these are mainly processed into feedstuff), potatoes and vegetables. Livestock production is the most important agricultural activity: sheep and lamb in the hills, dairy herds and beef on the lowlands. In general, foods from the area enter the overall UK food supply and are part of the pool of material available for export.

Commercial fishing data for the eastern Irish Sea[8], in particular where it concerns landings from registered vessels in local ports, generate the following estimated exports[9] to other Member States: some 320 t of fish landings mainly to the Netherlands, France, Germany and Ireland (in that order); about 3860 t of shellfish landings mainly to France, Spain, Italy and the Netherlands (in that order).

4.1.2 Radioactive discharges

The Sellafield site facilities discharge liquid effluent to the Irish Sea and airborne effluent into the atmosphere from several controlled discharge points.

The most significant part of the legal framework for discharge monitoring in Sellafield is formed by the UK's Environmental Permitting Regulations, and the EA's requirements. The site operator is in charge of monitoring, respecting standards and guidance provided by the regulator, and is subject to inspections. In addition, the EA carries out an independent liquid and gaseous discharge monitoring programme for comparison and reassurance purposes.

4.2 SEPARATION AREA VENTILATION FACILITY

4.2.1 Introduction

In order to facilitate monitoring and control of the large gaseous ventilation flows from several site facilities the Separation Area Ventilation (SAV) facility has been constructed. Its purpose is to collect the outflows into a single stack and to provide additional HEPA filtration and monitoring of radioactivity before discharge into the atmosphere. In 2016 the SAV facility became operational following the decision to demolish both the Magnox Primary Separation and Head End Plants Stack and the Pile Chimney Stack as they approached the end of their effective operational lives and are scheduled for demolition in the near future. The existing ventilation extracts were diverted into the SAV system via tie-ins to existing ductwork. The donor streams were re-routed outside the separation area, to the new plant room in the SAV for discharge via the SAV stack.

The scope of the SAV is to provide a 'flexible' ventilation system to support both current and future decommissioning activities. In the future also gaseous discharges from additional plants will be discharged via the SAV.

[8] Area bound by the British coast and longitude 4°W.
[9] These values are derived from generic export values for the entire UK (2012).

4.2.2 Description

The SAV is located within the Sellafield site. It comprises of a plant room, substation, 122 m stack and a stack monitoring room along with a new pipe bridge and numerous lengths of ductwork between donor plants and the SAV facility. The facility has a continuously manned control room. It has a staff of 15.

The SAV plant room and the stack monitoring room contain the fans, filters, ductwork and instrumentation to maintain the existing ventilation flow conditions from the donor plants. Figure 1 presents the SAV donor plants and its flow diagram. The SAV system is broadly split into three separate sections: systems 745 and 750 replace the existing discharge routes via the Magnox Primary Separation and Head End Plants Stack; system 755 replaces the existing discharge route via the Pile Chimney Stack.

The process ventilation systems within the SAV are described as follows:

- System 745 (SAV Vessel Vent System) provides forced extract ventilation from the Magnox Separation and Thermal De-nitration Plants Vessel Ventilation and Street 3 ventilation systems, upstream of the Magnox Primary Separation and Head End Plants Stack. The extract streams from the donor plants are combined prior to entry to the plant room building and undergo two additional stages of High Efficiency Particulate Air (HEPA) filtration prior to final discharge to atmosphere. Humidity is reduced by the use of an engineered hot air in-bleed into the system, which also provides extract from the filter room. The motive force for the airstream is provided by two dedicated high integrity extract fans, each sized to provide 100% of the total system design duty, operating on a one duty, one standby basis.
- System 750 provides forced extract ventilation from the Purification Plant and Primary Separation and Head End Plants Cell Ventilation systems, upstream of the Magnox Primary Separation and Head End Plants Stack. High level discharge is provided from any combination of four flues, fed from a common upsweep chamber, shared with System 755. The motive force for the airstream is provided by three dedicated high integrity fans, each sized to provide 50% of the total system design duty, operating on a two duty and one standby basis.
- System 755 provides forced extract ventilation from the Magnox Separation Plant and the Thermal De-nitration Plant Vessel Cell Ventilation systems, upstream of the Pile Chimney Stack. The extract streams from the donor plants are combined prior to entry to the plant room building and have a single stage of HEPA filtration prior to discharge to atmosphere via the SAV Stack. The motive force for the airstream is provided by three dedicated high integrity fans, each sized to provide 50% of the total system design duty, operating on a two duty and one standby basis.

The System 745 and 765 ducts have a number of tapping points to facilitate operation of stack sampling and monitoring instrumentation along their lengths. Each stack sampling and monitoring instrument cabinet has a dedicated sample line and trace heating; insulation is provided on the sample lines to reduce condensation. The sample nozzles in the duct are designed to provide isokinetic sampling. The accuracy of the sampling system is determined using sulphur hexafluoride (SF_6) testing. SF_6 tracer gas of a known concentration is injected upstream of the sample point, then measured at the sampler and the efficiency of the system is then determined. All the stack sampling and monitoring instrument cabinets have passed SF_6 testing.

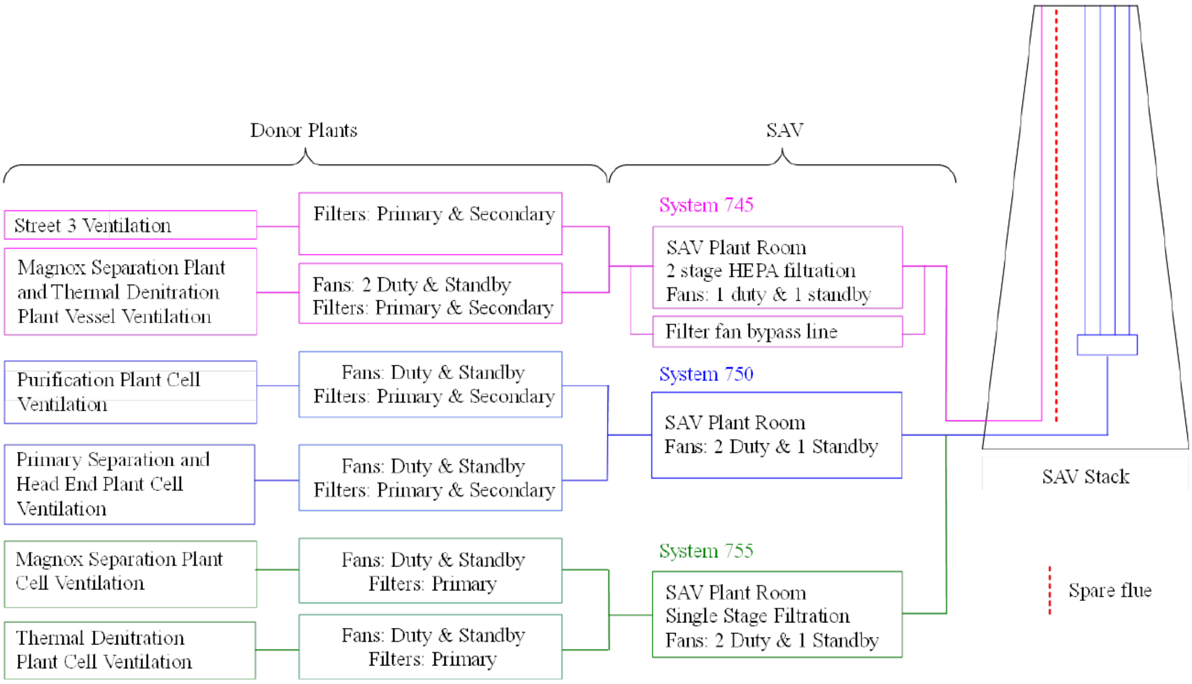

Figure 1. An overview of the SAV system and the donor plants

4.2.3 Monitoring systems

The alpha and beta monitors in the stack monitoring room (Figure 2) are iCAM instruments supplied by Canberra. The iCAM specifications include a measurement range in excess of 500 kBq of combined alpha and beta activity deposited on the filter. Measurement performance efficiency for alpha detection is 24% for all alpha up to 5.7 MeV, 24% for beta detection of ^{36}Cl or ^{90}Sr, and 15% for ^{60}Co. The detector is a Canberra Passivated Ion-implanted Planar Silicon (PIPS) detector assembly.

The ^{129}I monitors in the stack monitoring room are CMS1 L4 instruments supplied by Ultra Electronics (formerly known as Lab Impex). The specifications include a Minimum Detection Level of <10 Bq/m^3 I-131. The detector is a 45 mm thick NaI(Tl) crystal, optically coupled with a 50 mm photomultiplier tube.

The alpha and beta monitor in Filter Room 1 for HEPA filter monitoring is a CMS2000 instrument with a remote head assembly supplied by Ultra Electronics. The measurement range is <0.1 to 105 Bq/m^3 with a typical detection efficiency for alpha and beta of 22.5%. The detector is a high resolution PIPS solid state detector with 450 mm^2 active area.

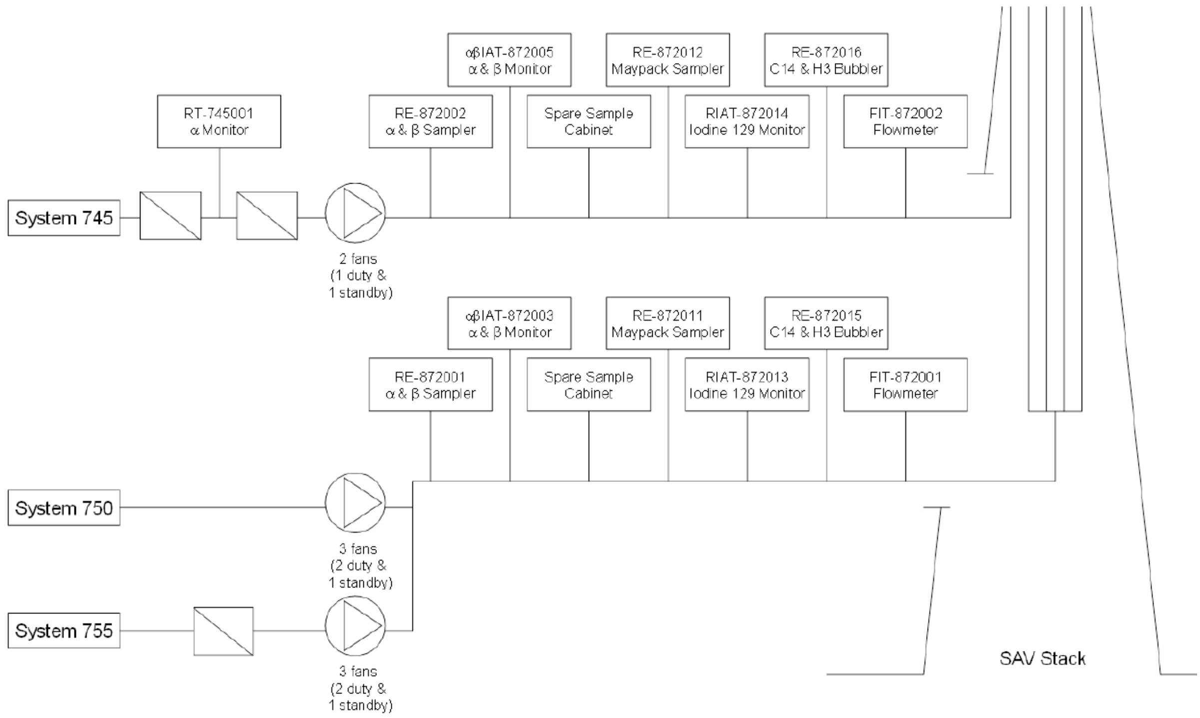

Figure 2. Samplers and monitors in the SAV

4.2.4 Radiation detectors and filters

Alpha and beta monitors

There are two alpha and beta monitors in the stack monitoring room (one on each system). For each monitor, an isokinetic sample probe with a draw-off rate of 37 l/min is inserted in the duct, and piped to the sampling system. In the sampling system the air passes through an isolation valve, an alpha and beta particulate monitor and back to the duct for safe discharge downstream from the sample probe.

The alpha and beta monitors measure airborne alpha and beta particulate activity with radon/thoron alpha and beta background compensation. The monitors also provide dynamic compensation of beta measurements for gamma background. Air is drawn through the instrument by means of an external pump and airborne particulate material is deposited on the removable card mounted filter. The filter is monitored by a robust Canberra Cams PIPS radiation detector, which allows simultaneous measurement of both alpha and beta radioactivity in the material deposited on the filter. The air flow is measured directly and reported by the instrument. The design of the airflow system is optimised to ensure high air sampling efficiency and high transmission of particles to the filter. The alpha and beta monitor has high detection efficiency for both alpha and beta particles and provides a good sensitivity for low energy beta detection.

^{129}I monitors

There are two ^{129}I monitors in the stack monitoring room (one on each system). For each monitor, a sample probe with a draw-off rate of 10 L/min is inserted in the duct, and piped to the sampling system. In the sampling system the air passes through an isolation valve and an in-line filter card holder. The filter removes dust and particulates so that they do not clog the iodine detector cartridge. The air then passes up through the detector assembly and back to the duct for safe discharge downstream from the sample probe.

The detector assembly comprises of a scintillation detector, monitoring a replaceable zeolite cartridge in the gas flow. The iodine detector consists of an opening lid, a detection chamber, a detection crystal and a photo multiplier tube. The detection chamber houses a zeolite filter through which the sample is passed. The inlet and outlet pipes are located in the side of the detector body. The detection chamber has a screw-on end cap with air seal. Inside is the detection chamber where a zeolite filter cartridge is located and lightly held. An electrical connection point is provided on the base of the detector body. The ^{129}I monitors continuously monitor the count rate from the detector, calculate and display activity concentration and provide programmable alarm levels. It also continuously monitors the air sampling rate. The ^{129}I monitors possess an alarm system designed to provide personnel with fast warning of high activity or fault conditions. The front panel incorporates three status Light-Emitting Diodes (LED) which allow quick and easy recognition of system status. The system continuously performs self-test routines.

Alpha and beta monitor for HEPA filter monitoring

There is an alpha and beta monitor located in Filter Room 1 for HEPA filter monitoring. An isokinetic sample probe with a draw-off rate of 37 l/min is inserted in the duct, and piped to the sampling system. A sample return probe is inserted into the duct downstream from the sample probe. In the sampling system, the air passes through a filter card holder which is part of the CMS2000 R remote detector head.

The CMS2000 R is the detector head used with the CMS2000 CAB+ controller. Air is drawn through the detector head by external vacuum pumps. It travels into the air inlet which has been carefully flowed to ensure that particulates accrete evenly across a filter card. Alpha and beta particulates deposited onto the filter card are monitored by two high efficiency PIPS detectors. A differential pressure switch detects a pressure drop across the filter card and provides an alarm signal if the card is damaged or missing. The airflow is continuously monitored by a temperature compensated mass flow meter and adjusted (manually) via the airflow regulator.

The CMS2000 CAB+ controller continuously measures radioactive particulates deposited on the card-mounted filter (25 mm diameter). It also continuously monitors the air sampling rate. The CMS2000 CAB+ controller possesses an alarm system to provide personnel with fast warning of high activity or fault conditions. The front panel incorporates three status LEDs which allow quick and easy recognition of system status.

Detector maintenance

The monitors are maintained by a specialist contractor. Typical maintenance on the monitors consists of a health check of the equipment prior to maintenance to ensure the equipment is not in fault. Pump operation and alarm checks are then carried out as well as flow rate and differential pressure checks and alarm tests. The response of the equipment to an appropriate test source is then checked to ensure the equipment alarms at its set points and that its efficiency is within acceptable levels.

4.2.5 Information flow

The SAV control room contains an annunciator panel and a Yokogawa paperless chart recorder. The stack sampling and monitoring instrument cabinets are hardwired to the SAV control room panels. The annunciator panel has audible alarms and a set of four push-buttons providing the following functions: alarm silence, alarm acknowledge, alarm reset and annunciator module test/lamp test. The SAV control room annunciator panel displays Level 2 and equipment failure alarms from the stack and duct monitoring and sampling equipment. Group alarms from the SAV Control Room are displayed in the donor plant and in the Centralised Control Rooms (Magnox Separation, Utilities and Low Active Effluent Management Group).

5 EMERGENCY MONITORING CAPABILITIES AT THE SELLAFIELD SITE

5.1 MOBILE MONITORING

5.1.1 Monitoring vehicles

Sellafield site has three District Monitoring Vehicles (DMV) (Figure 3). There are sufficient trained DMV Health Physics monitors on each shift to operate a minimum of two vans at all times (two per van). The DMVs can take measurements at any location around the site and have several options for communicating information back to the Site Emergency Control Centre (SECC).

A DMV can carry out the following monitoring functions:

- waist height gamma radiation;
- ground deposition by swab (alpha and beta/gamma);
- airborne activity by filter paper (using empty Maypack) (alpha and beta/gamma). Maypacks can be filled with charcoal or zeolite granules (both kept in the DMV) for measuring airborne volatile activity (e.g. iodine).

Each DMV has the following equipment:

- external air sampler (based on a Maypack holder) for taking 10 minute air samples;
- hand-held beta/gamma ion chamber;
- hand-held alpha/beta contamination probe;
- beta castle for filter papers and Maypack counting;
- alpha drawer unit for filter paper counting;
- iCAM monitor for airborne alpha and beta monitoring (i.e. for warning of high levels inside the van).

The DMV design allows all sampling to be carried out inside the van in order to minimise the risk of staff or equipment contamination. 43 off-site monitoring locations have been defined (most within 2-4 km, some 8-10 km, none beyond 10 km) (Figure 4).

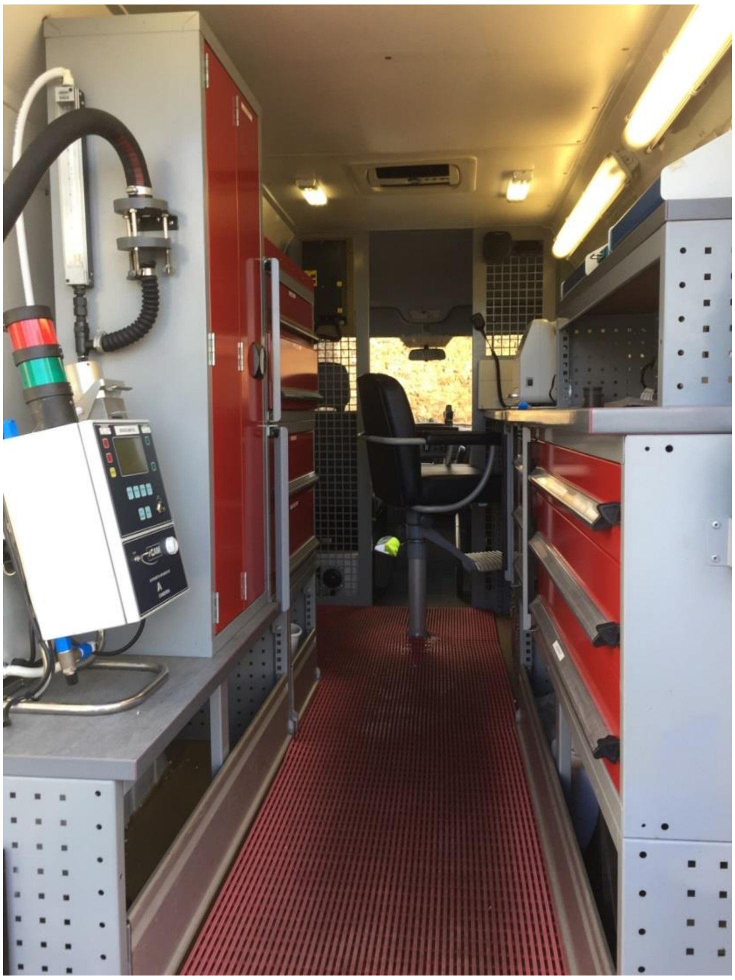

Figure 3. Interior of a District Monitoring Vehicle

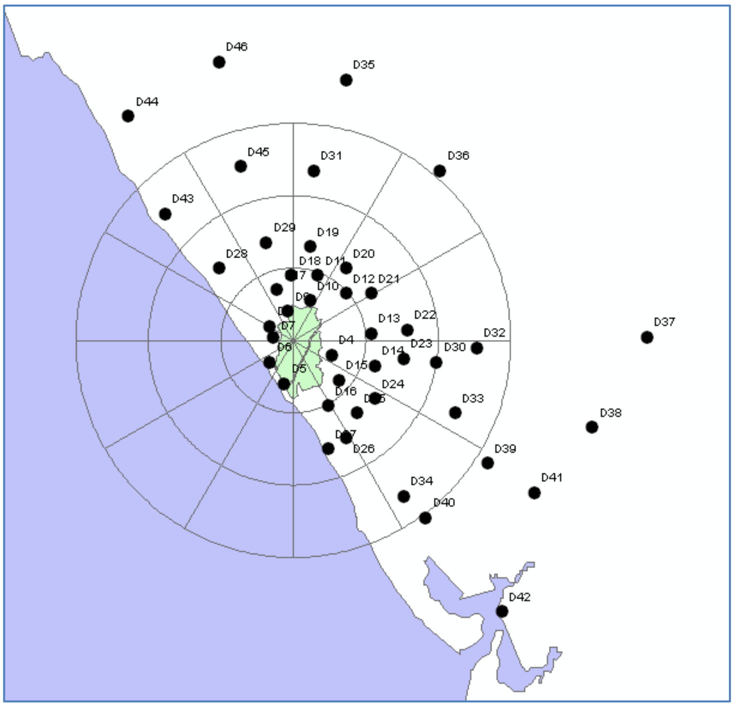

Figure 4. Pre-defined off-site monitoring locations in the Sellafield site vicinity

5.1.2 RIMNET cones

Sellafield deployable monitoring capability includes several mobile RIMNET Cones (Figure 5), which can be located in public access areas. These systems monitor gamma dose rate (Geiger Muller Tube 10 nGy/h – 3 mGy/h) and are equipped with GSM/GPRS communications and GPS positioning (UK OS grid reference, 10 m resolution). They have a weatherproof enclosure and internal shock and drop protection. Battery life is more than 100 hours. Data is provided directly to the Sellafield emergency centre and to the national RIMNET radiation monitoring system.

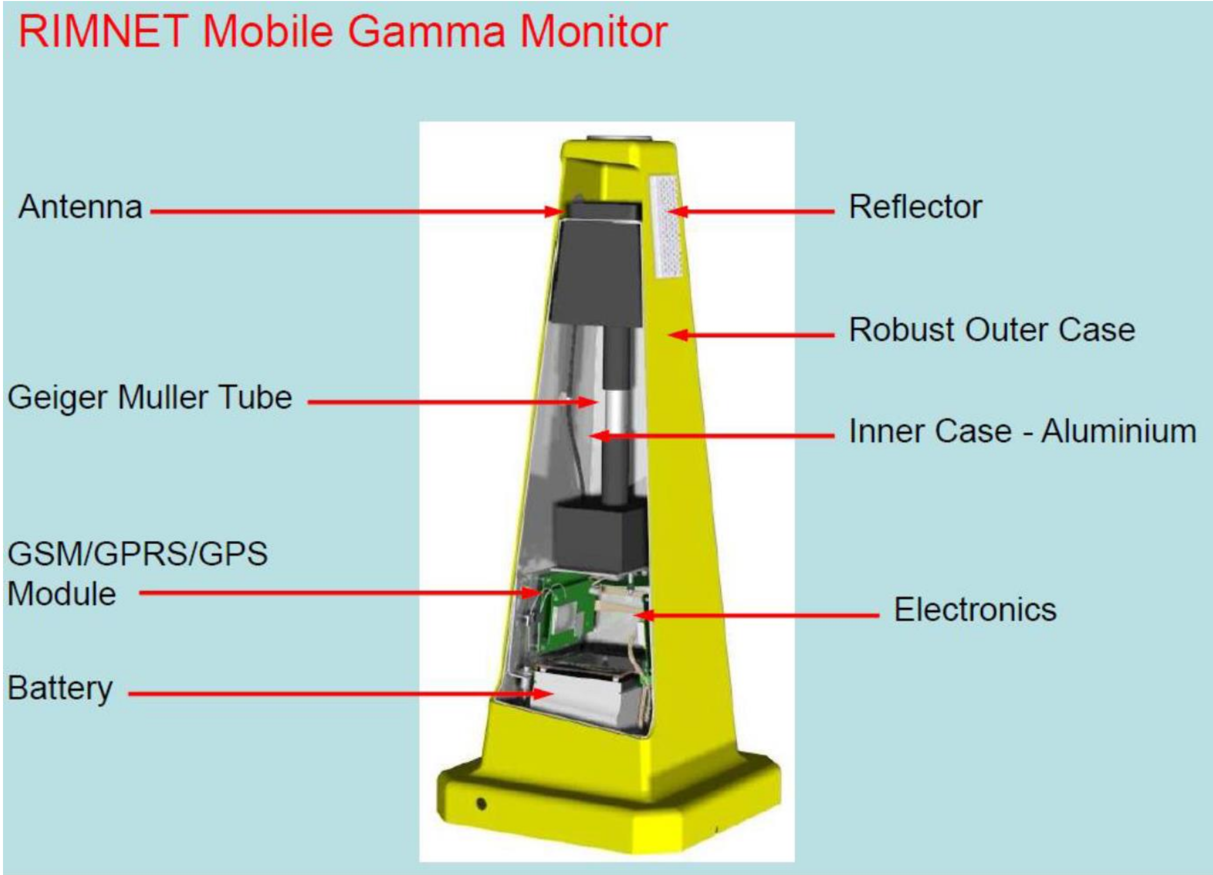

Figure 5. RIMNET cone

5.2 SITE MONITORING SYSTEMS

Continuous on-site radioactivity monitoring at the Sellafield site is carried out by the Site Perimeter Monitoring System (SPMS), Site Emergency Monitoring Points System (SEMPS) and a network of air samplers. The SPMS stations are placed on the site perimeter and SEMPS stations at the main buildings at the site (Figure 6).

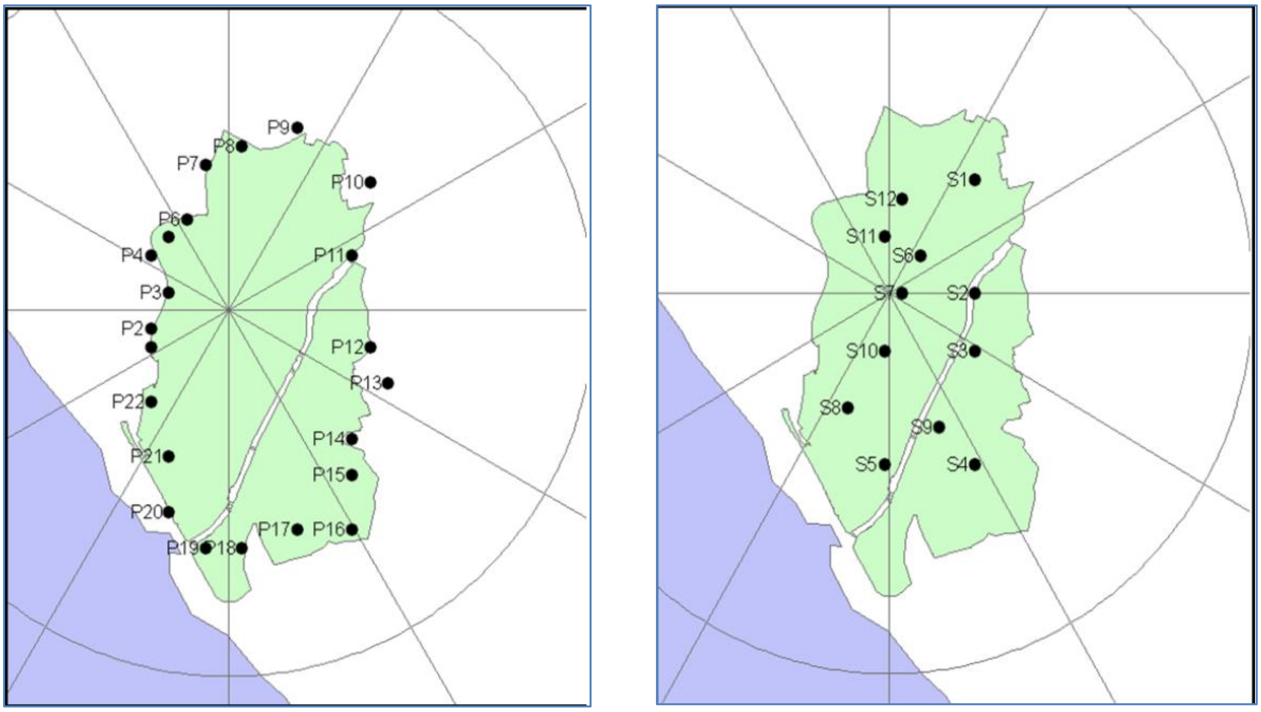

Figure 6. SPMS stations (left) and SEMPS stations (right)

5.2.1 Site Perimeter Monitoring System

The SPMS consists of 22 monitoring stations equipped with Alpha and Beta Monitors. The dual alpha and beta air sampler has a moving filter paper with lead shielding to reduce gamma radiation interference. The moving filter paper (10 mm/h using a 50 mm diameter detector) allows ongoing assessment of airborne activity.

The SPMS gamma monitor has two Geiger-Müller detectors covering high and low range dose rates. The system automatically switches between detectors at a predetermined dose rate.

The SPMS system has three alarm levels for each of the four measured values:

- An abnormal alarm level equivalent to the Council Food Intervention Levels (CFIL) values for beta and a minimum level for avoidance of spurious alarms for alpha. If exceeded an investigation is required.
- A shelter alarm level based on the shelter lower Emergency Reference Level (ERL). If exceeded an environmental assessment is required and exposed members of the public should be instructed to shelter.
- A evacuation alarm level based on the evacuation lower ERL. If exceeded an environmental assessment is required and exposed members of the public should be instructed to evacuate.

Public Health England (PHE) specifies lower and upper ERLs of averted dose for use in the planning of emergency countermeasures. Derived Emergency Reference Levels (DERL) are used by SL to guide emergency response decision-making and for setting emergency monitoring alarms.

Table I below presents the alarm levels.

Table I. SPMS Alarm levels

	Lower ERL mSv	**DERL Alpha Bq/m³**	**DERL Beta Bq/m³**
Shelter	3	6	9000
Evacuate	30	60	90000

5.2.2 Site Emergency Monitoring Points System

The SEMPS provides early warning capability for public and workforce protection. In addition its information can be used for planning evacuation routes in the event of an emergency. The system consists of 12 dual alpha and beta air samplers, which have a fixed card filter paper with lead shielding to reduce gamma radiation interference. The sampler provides air concentrations averaged an hour apart.

The SEMPS gamma monitor has a solid state detector for covering high and low dose rates. The system has three alarm levels for each of the three measured values (Table II).

Table II. SEMPS Alarm levels

	Alpha Bq/m³	**Beta Bq/m³**	**Gamma µSv/h**
Abnormal	1	20	1
Shelter	6	9000	10
Evacuate	60	90000	100

5.2.3 Air sampling at the site

There are five high-volume air sampler systems on the Sellafield site and 10 more in the surrounding district of the site. The air sampling systems operate on controlled flow rate of 69 m^3/h (electrically controlled according to pressure and temperature). The 10×8-inch filters are changed weekly, more often if needed. These samplers have no alarm function, but due to high sampling volume they provide detection capability for very low levels of radioactive contamination in the air.

6 MONITORING OF EXTERNAL GAMMA DOSE AND DOSE RATE IN THE SELLAFIELD SITE AND IN ITS VICINITY

6.1 ENVIRONMENT AGENCY MONITORING PROGRAMME

The EA undertakes independent monitoring in Cumbria as part of its Independent Monitoring of Radioactivity in the Environment Programme. Measurements of gamma dose rates above beach, inter-tidal and river bank areas are undertaken by an independent contractor (Figure 7). The absorbed dose rate in air (µGy/h) is measured in accordance with the *Technical Guidance Note (Monitoring) M5: Routine Measurement of Gamma Air Kerma Rate in the Environment*. Measurements are made using a Thermo Scientific™ Environmental Radiation Meter type 6-80 with a compensated Geiger-Müller tube type MC71.

Measurements are taken 1 m (and 15 cm for limited locations) above the terrain being monitored to the mid-point of the MC71, the probe being mounted vertically on a tripod. Where the topography of the site permits and where the geological conditions do not vary; three separate 600 second measurements are taken with the monitors situated approximately 10 m apart in the form of a triangle. Where the topography of the site does not allow a triangular arrangement of the probes, such as along a river bank or where the terrain is hazardous e.g. soft mud in estuaries, the probes are arranged in line 10 m apart.

All readings are recorded on paper notebooks and/or Chain of Custody Forms. Other information at the time of monitoring are also recorded, such as the prevailing weather, ground conditions and any unusual activities at the site.

Figure 7. Environment Agency gamma dose rate monitoring locations in Cumbria (green dots)

6.2 SELLAFIELD LIMITED MONITORING PROGRAMME

Figures 10 and 11 present the monitoring locations of the SL marine and terrestrial monitoring programmes. As part of these programmes, measurements of gamma dose rates above beach, inter-tidal and river bank areas are undertaken. The absorbed dose rate in air (µGy/h) is measured one metre above ground. Measurements are made using a Mini Instruments Environmental Radiation Meter type 6-80 with a compensated Geiger-Müller tube type MC71. Measurements are taken 1 m above the terrain being monitored to the mid-point of the MC71, the probe being mounted vertically on a tripod. Measurements are taken with the probes arranged in line 10 m apart. The gamma dose rate is measured with each detector over two 300 second periods. All readings are recorded on paper survey sheets.

In addition, gamma doses are monitored continuously around the site perimeter at 31 locations (Figure 9) and at further 7 locations in the surrounding district (co-located with the district high volume air samplers). Measurements are made using Thermo Scientific Harshaw TLDs (Figure 8). TLDs are deployed for 3 month periods in cylindrical Seibersdorf area dosimeter holders that consist of an aluminium protective cap and an inner plastic casing with a central slit to hold the TLD. The cap and inner casing are secured with a cable tie. If a TLD is lost or damaged, a spot measurement is taken.

Figure 8. TLD dosimeter and its Seibersdorf holder for environmental dose monitoring

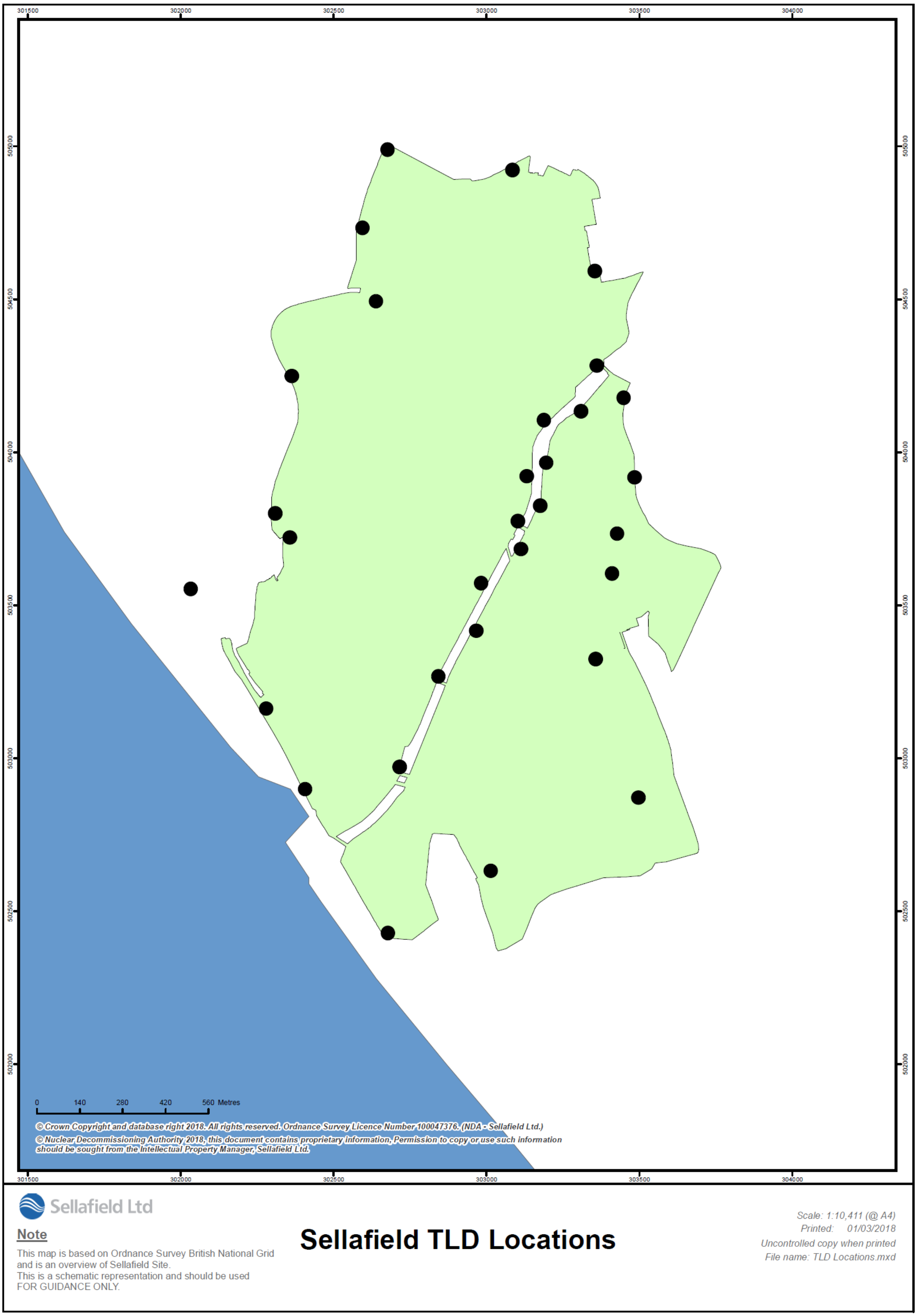

Figure 9. Sellafield site TLD locations

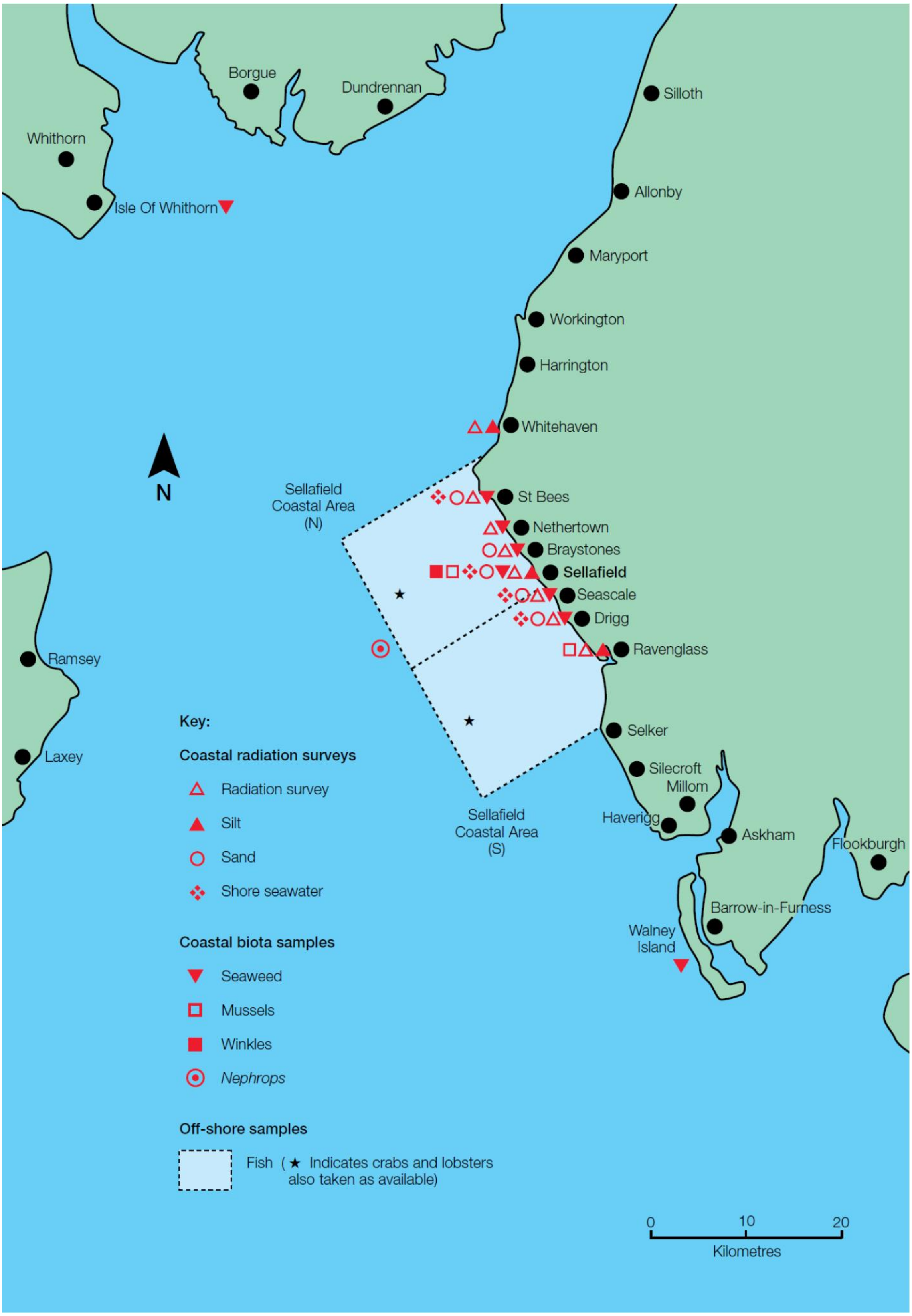

Figure 10. Sellafield Limited marine monitoring locations in Cumbria

Figure 11. Sellafield Limited terrestrial monitoring locations in Cumbria

7 MONITORING OF DRINKING WATER AT THE SELLAFIELD SITE AND IN ITS VICINITY

7.1 FRAMEWORK FOR MONITORING RADIOACTIVITY IN DRINKING WATER IN THE UK

7.1.1 Introduction

Monitoring of drinking water quality in England and Wales is regulated by the DWI together with local authorities. Responsibilities are shared depending on whether the water is distributed by the public or private supplies. Drinking water in the UK is provided either from public or private supplies and each has to follow different legislation and regulatory regime.

The independent national monitoring programme for radioactivity monitoring in drinking water sources is specified by the EA.

7.1.2 Public supplies

Public water supplies are defined as those that are provided by water companies; they cover over 99% of the population. Each region in the UK is served by a water company. In the vicinity of the Sellafield site drinking water is supplied by the private company United Utilities Limited (UU). It provides water and wastewater services and monitors the water quality including radioactivity parameters for approximately 3 million homes and 200,000 businesses across the region in the North West of England.

Strict standards for the quality of the UK public water supply are laid down in national regulations. The Water Supply (Water Quality) Regulations 2016 enacts the requirements for public supplies (i.e. water companies) to monitor radioactivity in drinking water. The DWI as the competent authority provides independent reassurance that public water supplies in England and Wales are safe and drinking water quality is acceptable to consumers.

All public supplies in the proximity area of Sellafield come from the Ennerdale WTW, with the exception of one (concessionary supply) property approximately 8 km south of Sellafield, near Ravenglass. All other customer properties within 15 km of the site are supplied from the Ennerdale WTW in the Water Quality zones Z031 Ennerdale North and Z032 Ennerdale South. Ennerdale takes water from Ennerdale Impounding Reservoir and blends this with ground water from four boreholes near Egremont.

7.1.3 Private supplies

Private water supplies in the UK cover less than 1% of the population and are in general terms those provided by someone other than the water companies. Most of these supplies are situated in remote, rural parts of the country and can originate from a range of sources (boreholes, natural springs and watercourses).

The Water Industry Act 1991, the primary national legislation, defines the powers and responsibilities of local authorities in relation to private water supplies. Local authorities act as the regulators for private water supplies and have a number of statutory duties under the Private Water Supplies (England) Regulations 2016.

People in around 500 properties in the Borough of Copeland get their water supply privately from a stream, well, borehole or spring on their property. SL uses drinking water (domestic water) from private water supplies.

The Copeland Borough Council (CBC) is the designated regulator for private water supplies of the Sellafield site within the Borough boundary. The Private Water Supplies Regulations place a duty on local authorities to conduct a risk assessment of each private water supply within their area and to undertake monitoring in order to determine compliance with the drinking water standards.

7.2 MONITORING OF DRINKING WATER IN AND AROUND THE SELLAFIELD SITE

The EA's national monitoring programme (Drinking Water Sources Programme) around the Sellafield site includes radioactivity monitoring of sources of drinking water from two locations (Ennerdale Lake and Haweswater reservoir) as shown in the Figure 12 below.

Raw water samples are taken by the water company staff weekly. Samples are collected to form a quarterly bulk sample separately for each analytical method:

- 1 bulk sample of 75 litres for gamma spectrometry and $^{90}Sr/^{3}H$ analyses;
- 1 bulk sample of 10 litres for gross alpha/beta analyses, total dissolved solids and stable element analyses.

Every three months the sealed bulk samples are sent to the contractor's laboratory by a courier. The radiochemical analyses of bulk water samples are carried out by the LGC Limited (LGC) laboratory in Teddington. In the LGC laboratory all relevant measurement methods for radioactivity analyses in drinking water are accredited to ISO17025.

Monitoring frequency, parameters and radionuclides as shown in Table IV are defined by the EA. LGC reports analyses results to the EA. The results from the drinking water sources programme is reported to the EC via the REM database and shared with water companies via the DWI.

Figure 12. Water sampling locations in Cumbria (blue dots)

Table IV. Drinking water source sampling frequencies and analytical requirements

Drinking Water Sources Programme		
Location	**Monitoring frequency (y^{-1})**	**Parameters and radionuclides**
Enerdale lake, Cumbria	4 (Quarterly bulk)	Gross alpha (as ^{242}Pu), Gross beta (as ^{137}Cs and ^{40}K), ^{3}H, ^{40}K, ^{90}Sr, ^{137}Cs, Stable K, Ca, Sr, TDS
Haweswater Reservoir, Cumbria	4 (Quarterly bulk)	Gross alpha (as ^{242}Pu), Gross beta (as ^{137}Cs and ^{40}K), ^{3}H, ^{40}K, ^{90}Sr, ^{137}Cs, Stable K, Ca, Sr, TDS

As part of SL's Environmental Monitoring Programme samples of tap water are analysed twice a year from 5 locations (Table V). Samples are taken by operational Sellafield Limited staff. The radioactivity analyses of tap water are undertaken on behalf of Sellafield Limited by the Cavendish Nuclear Limited (CN) laboratory located in Greeson Court. The laboratory analyses radionuclide concentrations on tap water samples (Gross alpha/beta, ^{3}H, ^{90}Sr, ^{137}Cs, Pu(α) and Am+Cm)

Table V. Tap water radioactivity monitoring locations at the Sellafield site and its vicinity

Location	**Frequency**
Whitehaven (tap water)	Biannual
Seascale (tap water)	Biannual
Calderbridge (tap water)	Biannual
Ravenglass (tap water)	Biannual
Sellafield (canteen)	Biannual

For public supplies in the vicinity of Sellafield drinking water radioactivity is measured by UU Sampling locations, frequency and the analysed radionuclides are presented in Table VI.

Table VI. Radioactivity monitoring of publicly supplied water around the Sellafield site

	Location	**Analyses**	**Frequency**
Operational samples	WTW/Supply point/Final water	Gross alpha and beta	2/year
		Tritium	1/year
		Gamma analyses	
	Raw water boreholes before treatment	Radon	1/year
National monitoring required by regulation	Ennerdale Lake and Haweswater Reservoir	Gross alpha and beta, Tritium, K-40, Sr-90	4/y

A study conducted by the UU for all its raw and final water sources has showed that none of the samples taken exceeded the trigger values for gross-α or gross-β; or the permitted concentration value for Tritium or Radon.

For public supplies, indicative dose is monitored using screening for gross alpha and gross beta in accordance with the screening strategy (b) in annex III of Council Directive 2013/51/Euratom. No samples have exceeded the screening value in this area so no further radionuclide analysis has been conducted. Tritium has been measured but no samples have exceeded the parametric value.

7.3 PARTICIPATING LABORATORIES

There are several laboratories involved in drinking water analysis of the Sellafield area. LGC and UU are the two laboratories providing radiochemical analyses on drinking water samples from the vicinity of Sellafield site. CN analyses tap water samples from the Sellafield site and its vicinity. All three laboratories are accredited to ISO17025 in the measurement methods relevant to determine radioactivity in drinking water.

7.3.1 LGC Limited

The LGC laboratory is subcontracted by the EA to measure the water samples from the surroundings of the Sellafield site. The laboratory measures water samples as defined in the national monitoring programme of drinking water. The LGC is required to submit measurement results of analyses (^{40}K, ^{137}Cs and other gamma emitters, total alpha/beta, Tritium, ^{90}Sr, Total K/Ca/Sr, total dissolved solids) to the EA.

7.3.2 United Utilities Limited

The UU laboratory located in Warrington analyses the water samples from public supplies in the region around Sellafield. Analytical capabilities of the UU laboratory are explained further in paragraph 8.4.2.

7.3.3 Cavendish Nuclear Limited

CN is an independent laboratory subcontracted by SL. It analyses the samples of tap water from the Sellafield site and its vicinity (Gross alpha and beta, Gamma-ray emitting radionuclides, Tritium, ^{90}Sr, Pu Alpha, and Am + Cm).

8 VERIFICATIONS

8.1 GENERAL

The verification team was informed about the Sellafield routine and emergency environmental radioactivity and drinking water monitoring arrangements before starting the verifications. The verifications were carried out according to the agreed programme (Annex 1).

8.2 SAV FACILITY

The verification team visited the SAV facility and verified the on-line and off-line monitoring systems. All monitors and samplers receive a sample via isokinetic flow through a sample nozzle in the main duct. Monitoring devices of systems 745 and 755 receive a bypass air flow from the main discharge line after the HEPA filters. System 750 air flow originates from the remediation plants with fairly low activity, thus no HEPA filters are needed. Sample airflows are returned to the main flow after the other samplers to avoid double sampling. The total flow is discharged to the atmosphere via the main stack at 122 m height.

The following monitors in systems 745 and 765 were presented to the team:

- Alpha/beta samplers (paper filter);
- Alpha/beta monitors (Canberra iCAM);
- Maypack samplers for gaseous Iodine sampling;
- Sampling system flow meters;
- ^{129}I monitors (Lab Impex Systems CMS-1RL4);
- Bubbler samplers for ^{14}C and ^{3}H;
- Total flow (Pitot tube array) and flow profile measurement systems;
- Alpha monitor (RT-745001) in the HEPA filter room (filter performance monitoring).

Sample change procedures were explained to the team. In the control room the team verified the data panel and logging systems. In addition the SAV UPS battery room (back-up electrical power for the monitoring equipment) and the training mock-up of the HEPA filter change procedure were presented to the team.

No remarks.

8.3 ROUTINE AND EMERGENCY MONITORING

8.3.1 Site Emergency Monitoring Points System

The verification team verified station 11 of the SEMPS. Altogether there are 12 such stations at the Sellafield site. It consists of a fixed filter air alpha/beta monitor (Harwell AB96, nominal flow rate 2.2 m^3/h) and a gamma dose rate monitor. Airflow through the filter is not measured, but there is an alarm for a no flow situation. The filter is changed weekly, but it is not measured in a laboratory.

The SEMPS system stations have no electrical back-up and they are approaching the end of their operational lifetime.

Verification does not give rise to recommendations. The verification team supports the on-going process to modernise the SEMPS stations in the near future.

8.3.2 Site Perimeter Monitoring System

The verification team verified station 3 of the SPMS. The station consists of an alpha/beta monitor using a rolling filter paper (Berthold BAI 9100-D, nominal airflow 4 m^3/h) and a gamma dose rate monitor (separate high and low ranges).

The radiation monitoring equipment is placed in a large heated container. Altogether there are 22 such containers on the Sellafield site perimeter; four of them have additional equipment for measuring also wind speed and direction. The containers have no electrical power back-up, but there is a connector for an external generator.

The SPMS monitoring containers are about 30 years old, but still functional. The verification team was informed that the replacement process of these equipment is already underway.

Verification does not give rise to recommendations. The verification team supports the on-going process to modernise the SPMS stations in the near future.

8.3.3 District Monitoring Vehicle

The verification team verified one of the district monitoring vehicles. This is a basic mobile laboratory based on a Mercedes Benz Sprinter van. Altogether there are three such vehicles in operation; three new vehicles were being commissioned at the time of the verification.

Sampling and monitoring equipment of the vehicle were presented to the team. All equipment in the vehicles have been designed to support sampling from inside to minimise the probability of equipment or staff contamination – for example surface swipe samples can be taken through a hatch on the vehicle floor. The vehicles are equipped with autonomous electrical power generators and UPS systems.

The verification team was informed that altogether there are some 210 staff members trained to use the equipment of the vehicles, thus in the event of an emergency 24h monitoring capability can be maintained. Vehicles have been designed with fairly simple equipment in order to avoid the need for highly specialised monitoring staff – for example there is no mobile gamma spectroscopy equipment included. Typically the vehicles would monitor the radiological situation in the 43 pre-arranged off-site locations within 10 km from the site. They can also be deployed to population centres, which according to atmospheric dispersion models could be affected in the event of an emergency.

No remarks.

8.3.4 Site air sampler

The verification team verified the operation of one of the nine High-Volume Air Samplers (HVAS) on the Sellafield site. Sampler filter change was demonstrated. The current HVAS equipment was installed in 2014. There is no back-up electrical supply.

No remarks.

8.3.5 TLD monitors

A TLD monitor used to monitor ambient dose (Air Kerma H*10) at Sellafield was presented to the verification team. The system comprises altogether 38 TLD detectors placed in Seibersdorf holders made of aluminium.

No remarks.

8.3.6 Improvement projects

The verification team was informed about the ongoing or planned improvements in the Sellafield site emergency monitoring systems. These include:

- Improved command and control facility;
- RIMNET gamma dose rate cones (15 units);
- New district monitoring vehicles (3 units);
- Drop & Go monitors (alpha/beta/gamma);
- Mobile gamma spectroscopy;

- SEMPS and SPMS replacement.

The verification team supports the improvement projects.

8.4 DRINKING WATER MONITORING

8.4.1 Egremont boreholes

The verification team visited the Egremont boreholes, which provide about 20% of the drinking water used in the vicinity of the Sellafield site. The UU representatives explained how the water monitoring arrangements are made at the site.

Drinking water in the vicinity of Sellafield is a mixture of the water from the Ennerdale Impounding Reservoir (80%) and ground water from four boreholes near Egremont (20%). Blended water is sent to the Ennerdale water treatment works where it is distributed to consumers. It is the responsibility of the UU to monitor the water quality parameters, including radioactivity. Samples of final water for radioactivity analysis are taken at the Ennerdale treatment works before water is distributed to the customers. Operational routine samples of raw water are taken from each individual borehole and from blended water at the Egremont borehole site.

No remarks.

8.4.2 United Utilities Limited laboratory

The verification team verified the radiochemical measurement facility of the United Utilities Limited laboratory in Warrington. The facility is equipped for radioactivity measurements in drinking water. There are altogether 4 staff members trained for relevant analytical methods. The following methods for determination of radioactivity in water samples are accredited by UKAS to ISO17025:

- Gross alpha/beta in raw and drinking water
- Determination of gamma-ray emitting nuclides in energy range 60-2000 keV in drinking water
- Determination ^{222}Rn in raw and drinking water

The laboratory has the following counting systems:

- One 10-channel gas proportional counter for low level gross alpha/beta measurement (Berthold)
- Two HPGe gamma spectrometers (Ortec)

The UU laboratory is not equipped to measure Tritium in water samples. Those analyses are subcontracted to the LGC laboratory located in Teddington. The LGC laboratory holds ISO17025 accreditation for Tritium analyses in water.

UU has been granted a notice not to monitor for specific parameters in the area because the levels of radon, tritium and indicative dose remain below the respective parametric values in accordance with Annex II of Council Directive 2013/51/Euratom, but it continues to do operational monitoring for gross alpha, gross beta and tritium and for gamma on Ennerdale Water Treatment Works.

The laboratory carries out regular monitoring of the equipment stability and participates annually in intercomparison exercises on both gamma and alpha/beta measurements.

Sample results are submitted to the DWI. The verification team noted that unlike other drinking water quality parameters, radioactivity data is not made available to the public at the UU public website.

The verification team noted that having only one fairly old gas proportional counter may lead to lack of measurement capability in the event of an equipment failure. The team was informed that the UU laboratory has back-up arrangements with other laboratories in place for this type of situation.

The verification team recommends that the DWI assesses the need for carrying out a country-wide inquiry on the availability of drinking water radioactivity data on the public websites of the regional water companies.

The verification team recommends that the UU makes also drinking water radioactivity data available to the public via its website.

The verification team suggests acquiring an additional counting system for gross alpha/beta measurements at the UU Warrington laboratory.

9 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, were to a high standard and proved very useful.

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

(1) The verification activities found that the facilities to carry out continuous monitoring of levels of radioactivity in the gaseous discharges from the SAV facility are adequate. The Commission could verify the operation and efficiency of these facilities.

(2) The verification activities found that the facilities to carry out continuous monitoring of levels of radioactivity in the environment in the event of an emergency at the Sellafield site are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(3) The verification activities found that the facilities to carry out continuous monitoring of levels of radioactivity in drinking water in the vicinity of the Sellafield site are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(4) A few recommendations and suggestions are formulated. Notwithstanding these recommendations the verified parts of the monitoring system for environmental radioactivity and drinking water in place are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

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

(6) The Commission services kindly request the United Kingdom authorities to submit a report on any significant changes in the set-up of the monitoring systems, before the end of 2019, or before the end of the applicability of the Euratom Treaty to the United Kingdom, whichever comes first.

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

ANNEX 1

VERIFICATION PROGRAMME

Wednesday 22 November 2017

Environment Agency, Penrith

12.00	Welcome and Introduction Dr. Allott, EA
12.10	Article 35 Verification Programme Introduction Mr. Tanner, EC
12.20	Overview Ms. Fallon, BEIS
12.30	Drinking-Water Monitoring Arrangements for the Sellafield Vicinity Mr. Marsden, DWI – how national regulations apply, drinking water requirements of the Euratom Directive Ms. O'Reilly, Copeland BC - local arrangements, sampling and sources, private water supply regulations, map Dr. Allott, EA – monitoring responsibilities, sampling and auditing, sample results from vicinity of Sellafield site.
13.00	Introduction to Drinking-Water Monitoring Arrangements at the Sellafield Site Ms. Greggain, SL - monitoring responsibilities, abstraction to water treatment analysis Ms. O'Reilly, Copeland BC – monitoring responsibilities
13.30	Gaseous Discharge Monitoring at the Sellafield Site: Separation Area and Ventilation Stack Dr. Allott, EA – general framework Mr. Webley, SL – Separation Area Ventilation (SAV) Dr. Allott, EA – check monitoring arrangements
14.30	National Emergency Preparedness, Response and Recovery Policy Ms. Fallon, BEIS
15.00	Emergency Monitoring Arrangements for the Sellafield Vicinity Mr. Kershaw, Cumbria CC – multi-agency approach Mr. Stevens, SL – emergency monitoring arrangements, what SL would do in emergency situation Mr. Desmond, SL – environmental TLDs Mr. Thomas, FSA – what FSA would do, recovery, food monitoring Dr. Allott, EA – what EA would do in emergency situation Ms. O'Reilly, Copeland BC
16.00	Q & A and Close

<u>Thursday 23 November 2017</u>

Sellafield Site, Cumbria

09.00 <u>Welcome / Safety briefing at Yottenfews Farmhouse, Sellafield Site</u>
Mr. Desmond, SL

09.30 <u>Verification of Separation Area Ventilation (SAV) Facility, Sellafield Site</u>
Mr. Desmond, SL

12.30 <u>Mobile Monitoring</u>
Mr. Desmond, SL – District Monitoring Vehicles (DMV)
Mr. Desmond, SL – Mobile Monitoring - RIMNET cones

13.00 <u>Verification of Radiation Monitoring Arrangements</u>
Mr. Desmond, SL – Site Emergency Monitoring Points System (SEMPS)
Mr. Desmond, SL – Site Perimeter Monitoring System (SPMS)

13.40 <u>De-Brief at Yottenfews Farmhouse, Sellafield Site</u>
Mr. Desmond, SL

Off-Site Egremont Boreholes, Cumbria

14.10 <u>Verification of Site Ground Water Monitoring Arrangements, Egremont Boreholes</u>
Mr. Halford-Maw, UU

<u>Friday 24 November</u>

United Utilities Laboratory, Warrington

09.00 <u>Welcome and Introduction</u>
Mr. Halford-Maw, UU

10.00 <u>UU Laboratory Tour</u>
Mr. Halford-Maw, UU

12.00 <u>De-Brief and Close</u>
Mr. Halford-Maw, UU