EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

SELLAFIELD
CUMBRIA
UNITED KINGDOM

8 to 12 March 2004

Reference: UK-04/1

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Installations for monitoring and controlling radioactive discharges and for surveillance of the environment in Cumbria during normal operations of the Sellafield site.
SITE:	Cumbria, United Kingdom.
DATE:	8 to 12 March 2004.
REFERENCE:	UK-04/1.
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TECHNICAL REPORT

1. ABBREVIATIONS

AECWP	Aerial Effluent Control Working Party (BNFL)
APP	Accountancy Point Plant (BNFL)
BNFL	British Nuclear Fuels plc
BPM	Best Practicable Means
BPT	Break Pressure Tank
CA	Certificate of Authorisation
CCR	Central Control Room (BNFL)
CEAR	Compilation of Environment Agency Requirements
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFA	Conditions For Acceptance (BNFL)
CoP	Code of Practice
DCG	Discharge Control Group (BNFL)
Defra	Department of the Environment, Food, Agriculture and Rural Affairs
DTI	Department of Trade and Industry
EA	Environment Agency
EAGLE	Environmental Analysis of Gaseous and Liquid Effluents database (BNFL)
EARP	Enhanced Actinide Removal Plant (BNFL)
EC	European Commission
EHS	Environment and Heritage Service for Northern Ireland
EMA	Environmental Monitoring and Assessment group (BNFL)
EMP	Environmental Monitoring Programme
EU	European Union
FSA	Food Standards Agency
GSL	Geoffrey Schofield Laboratories (BNFL subsidiary)
HEPA	High Efficiency Particulate Absolute (air filter)
HMIP	Her Majesty's Inspectorate of Pollution (now Environment Agency)
LAEMG	Low Active Effluent Management Group (BNFL)
LEC	Liquid Effluent Co-ordinator (BNFL)
LECWP	Liquid Effluent Control Working Party (BNFL)
LGC	Laboratory of the Government Chemist
LSC	Liquid Scintillation Counter
LSN	Laboratory Sample Number (BNFL)
MAFF	Ministry of Agriculture, Fisheries and Food (now Defra)
NAMAS	National Measurement Accreditation Service (replaced by UKAS)
NII	Nuclear Installations Inspectorate
NRPB	National Radiological Protection Board
QAAM	Quality Assured Analytical Method
QA	Quality Assurance
QNL	Quarterly Notification Level (of radioactive discharge)
RAL	Rolling Annual Limit
RIFE	Radioactivity In Food and the Environment (report)
RQNL	Rolling Quarterly Notification Levels
SCO	Stack Co-ordinator (BNFL)
SETP	Segregated Effluent Treatment Plant (BNFL)
SIXEP	Sellafield Ion Exchange Effluent Plant (BNFL)
SLIMS	Sellafield Laboratory Information Management System (BNFL)

SMP	Sellafield MOx Plant (BNFL)
SSP	Sellafield Site Procedure
TEROMAN	Sellafield site maintenance management system (BNFL database)
THORP	Thermal Oxide Reprocessing Plant (BNFL)
TID	Technical Implementation Document (BNFL)
UKAS	United Kingdom Accreditation Service

2. INTRODUCTION

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

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

For the EC, the Directorate-General for Energy and Transport (DG TREN) and more in particular its Radiation Protection Unit (TREN H4) is responsible for undertaking these verifications.

For the purpose of such a review, a verification team from DG TREN visited the Sellafield site located on the coast of Cumbria, operated by BNFL.

The visit also included meetings with the Department for Environment, Food and Rural Affairs (Defra), the Environment Agency (EA) and the Food Standards Agency. Details of the programme are given under section 3 below.

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance at and around the Sellafield site. The purpose of the review was to provide independent verification of the adequacy of monitoring facilities for:

- Discharges of radioactivity 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.

With due consideration to the scope of the verification mission and taking into account the relatively short time available for the execution of the programme, it was agreed that emphasis would be put on:

- The operator's monitoring and control facilities for gaseous and aqueous discharges of radioactivity into the environment, more in particular with respect to the following plants: THORP (thermal oxide reprocessing plant), SMP (Sellafield MOx plant), SIXEP (Sellafield ion exchange plant), EARP (Enhanced actinide removal plant) and SETP (Segregated effluent treatment plant).
- The implementation of the statutory environmental radioactivity monitoring programme as performed by the operator.
- The operator's effluent and environmental laboratories, including aspects of quality assurance and control as well as document control.
- The independent environmental monitoring programme as performed by the UK competent authorities (Environment Agency and Food Standards Agency).

The present report is also based on information collected from documents referred to under section 3 and from discussions with various persons met during the visit, also listed under section 3 below.

1 Directive 96/29/Euratom

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1. Preamble

The Commission's decision to request the conduct of an Article 35 verification was notified to the UK Government on 18 December 2003 (letter referenced TREN/H4/SVdS/hm D(2003)22064, addressed to the UK Permanent Representation to the European Union). The UK Government subsequently designated the Department for Environment, Food and Rural Affairs (Defra) to lead the technical preparations for this visit.

3.2. Documents

In order to facilitate the work of the verification team, a package of information was supplied in advance by Defra. 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.

3.3. Programme of the visit

The EC and Defra discussed and agreed upon a programme of verification activities, with due respect to the 1993 Protocol (memorandum of understanding) between the UK authorities and the EC, setting out the framework and modalities within which Art.35 verifications are to be conducted. However, the UK government accepted to widen the scope of the agreed framework to encompass technical installations for monitoring airborne and aqueous radioactive discharges to the environment. The EC appreciates this voluntary offer as it allows an overall assessment of the environmental monitoring; including the points of release of radioactive discharges as well as the methods of control put in place at those points.

During the information meeting presentations were given on the following topics:

- The Sellafield site – introduction.
- The Sellafield Discharge Authorisations.
- The BNFL environmental monitoring programme.
- The EA environmental monitoring programme.
- The Food Standards Agency foodstuff monitoring programme.

The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

A summary overview of the programme of verification activities is provided in Appendix 2.

The verifications were carried out in accordance with the programme.

3.4. Representatives of the UK competent authorities, the operator and associated laboratories

During the visit the following representatives of the national authorities, the operator and other parties involved were met:

<u>The Department of the Environment, Food, Agriculture and Rural Affairs</u>:

Mr B. Oliver	Head of Radioactive Substances Branch 1 (RAS 1)
Dr M. Hum	Head of International Policy (RAS 1)

The Environmental Agency:

Dr R. Allot	Technical Manager, Radiological Monitoring and Assessment Team Monitoring and Assessment Process Group
Ms J. Rowe	Technical Advisor, Radiological Monitoring and Assessment Team Monitoring and Assessment Process Group
Mr B. Russ	Policy Manager (International) Radioactive Substances Regulation
Dr M. Emptage	Nuclear Regulator, Nuclear Regulation Group (North)
Mr M. Gilbert	Nuclear Regulator, Nuclear Regulation Group (North)
Mr A. Mayall	Nuclear Regulator, Nuclear Regulation Group (North)
Mr P. Orr	Nuclear Regulator, Nuclear Regulation Group (North)

The Food Standards Agency:

Mr P. Tossell	Team Manager, Terrestrial Radiological Monitoring Programme & RIFE editor
Mr N. Wood	Team Manager, Aquatic Radiological Monitoring Programme
Ms K. Thomas	Assistant Manager, Aquatic Radiological Monitoring Programme

British Nuclear Fuels plc:

Dr R. Strong	Head of Environmental Management
Mr N. Coverdale	Manager, Environmental Regulations
Mr T. Parker	Manager, Environmental Monitoring and Assessments
Ms N. Cayley	Member of Environmental Improvements (Radioactive) Team
Mr J. Desmond	Environmental Monitoring Manager
Ms M. Lambon-Wilks	Senior Assessor
Mr A. Dalton	Environmental Assessments Manager
Mr M. Hadwin	Environmental Monitoring Team Leader
Ms C. Stephenson	Environmental Monitoring Health Physics Monitor
Mr A. Lewitt	SMP Technical Support Officer
Mr J. Field	THORP Oxide Fuel Storage Group Manufacturing Support Manager
Mr A. Howis	THORP Operational Services Team Leader
Mr M. Simmonds	THORP Fuel Services Manufacturing Support Officer
Mr K. Stewart	EARP Manufacturing Manager
Mr G. Cunningham	SETP Manufacturing Manager
Mr M. James	SETP Shift Team Leader
Ms J. Rutherford	SIXEP Manufacturing Manager
Mr R. Lewis	Magnox East River Technical Support, Liquid Effluent Co-ordinator
Mr B. Rogerson	Analytical Services Manufacturing Manager
Ms S. Calvin	Analytical Services Analytical Liaison Officer
Ms H. Edwards	Analytical Services Analytical Liaison Officer
Ms A. Carruthers	Analytical Services Dispensary Laboratory Leader
Ms M. Herbert	Analytical Services Team Leader
Mr J. McQuirk	Analytical Services Laboratory Team Leader
Mr A. Goodwin	Analytical Services Laboratory Analyst
Mr M. Breese	Environmental Advisor

The Geoffrey-Scofield Laboratories:

Mr I. Maidment	GSL Laboratory Manager

Scientifics Limited:

Ms G. Guiguet-Doron	Environmental Technologist

The verification team acknowledges the co-operation it received from all individuals mentioned.

4. THE SELLAFIELD SITE – SHORT DESCRIPTION OF PLANTS VISITED

4.1. Thermal Oxide Reprocessing Plant THORP

THORP was developed in the early 1970's as BNFL recognised the need for a facility to reprocess spent oxide fuels from the new generation of Advanced-Gas Cooled and Light-Water Reactors (LWR), and to recover the re-usable material. The plant consists of three main areas: Receipt and Storage (R&S), Head End and Chemical Separation (Chemsep).

R&S is the storage facility prior to the spent fuel being reprocessed. The fuel is stored within the pond in containers until such a time as it is scheduled for reprocessing. LWR fuel must remain within the pond for a period of at least three and a half years. These storage periods are sufficient to allow some of the more short-lived radioactive isotopes in the fuel to decay. The pond water is purged at regular intervals and subsequently released into the marine environment after sampling and monitoring. However, there is also a separate area within the pond, which is allocated to feed the fuel forward to the Head End Plant. Here the containers are vented and purged, where the water from inside the containers is removed and sent to the Enhanced Actinide Removal Plant.

Within the Head End section of the plant the spent fuel is chopped into smaller pieces ready for dissolution. Here the spent fuel is dissolved in nitric acid, leaving the pieces of fuel cladding behind. During this process off-gases are produced which are extracted within the Dissolver Off Gas (DOG) system for treatment/abatement prior to release at atmosphere. The liquid from dissolution is clarified and then fed forward into the Chemsep part of the plant. The DOG caustic scrubber liquors are treated in the THORP Carbon-14 plant with Carbon-14 being extracted into a slurry which is then encapsulated as a solid material for long term storage and, where appropriate returned to customer. Supernatant liquors from this process are discharged to sea after sampling and monitoring.

The purpose of Chemsep is to separate out the uranium, plutonium and waste fission products followed by purification and finishing of the uranium and plutonium streams. The uranium is drummed into containers and stored in a specialist-designed product store, as is the plutonium. The waste fission products are then fed into the High Level Waste Plants for storage and evaporation prior to vitrification.

The main aerial effluents from THORP are discharged to atmosphere after sampling via THORP stack.

4.2. Enhanced Actinide Removal Plant (EARP)

EARP was designed specifically to remove alpha activity and to reduce beta activity from liquid effluent streams resulting from historical and future reprocessing operations. These effluent streams contain iron in solution that forms a ferric floc on addition of sodium hydroxide in EARP.

Having precipitated the ferric floc (which contains most of the plutonium and alpha activity) from the feed liquors, an ion exchange reagent is added which removes mainly caesium from solution into the floc. The floc is dewatered by ultrafiltration to produce a final floc for encapsulation with cement in 500 litre drums in the Waste Packaging and Encapsulation Plant. The remaining permeate is sampled and sentenced prior to sea discharge.

4.3. Site Ion Exchange Plant (SIXEP)

SIXEP began operation in 1985 and is part of a suite of plants utilised specifically to decrease discharges into the environment. The plant was designed purposely to reduce levels of soluble caesium and strontium species within liquid effluents.

The plant treats pond water from various fuel storage ponds across the site. The process involves feeding the pond water through sand filters to remove any suspended solids; it is then neutralised prior to ion exchange. After neutralisation the filtered effluent is fed through an ion exchange medium that ‘exchanges’ radioactive caesium and strontium for non-radioactive sodium. The treated effluent is normally discharged continuously to sea via the Break Pressure Tank. A proportional sampler continuously collects a liquor sample for retrospective accountancy. The treated effluent is continuously monitored by an in-line gamma monitor that will automatically stop the discharge pump and close its discharge valve on detection of higher than normal activity.

4.4. Segregated Effluent Treatment Plant (SETP)

SETP is designed to handle low risk, low active acidic and alkaline effluents arising from THORP and Magnox reprocessing operations, in addition to other feeds from across the site.

The acidic effluents are made alkaline by the addition of sodium hydroxide prior to mixing with the alkaline stream. The combined effluent is filtered to remove debris prior to transfer to one of three SETP sea tanks where it is proportionally sampled and sentenced prior to discharge to sea.

4.5. Sellafield Mox Plant (SMP)

SMP was built to manufacture PWR (Pressurised Water Reactor) and BWR (Boiling Water Reactor) pellets, rods and complete fuel assemblies. Utilising Plutonium Dioxide (PuO_2) and Uranium Dioxide (UO_2) powders produced via reprocessing operations, SMP provides a recycle process, enabling the powder to be reused to create a further source of fuel (production of fuel elements).

Liquid effluents from SMP are routed to SETP via THORP for treatment prior to discharge into the marine environment. The main aerial effluents from SMP are discharged to atmosphere after sampling via THORP stack.

4.6. Break Pressure Tank (BPT)

BPT receives effluent streams from plants on site and the combined effluent is discharged from the BPT to sea through Sea Line 3. Normally all low or trace active liquid effluent discharged from the Sellafield site, apart from the lagoon effluent, passes through the BPT.

5. COMPETENT AUTHORITIES & LEGAL BACKGROUND

5.1. Introduction

Within the UK the Radioactive Substances Act 1993 (RSA 93) provides the framework for controlling the generation and disposal of solid, liquid and gaseous radioactive waste so as to protect the public and the environment. In particular, RSA 93 requires prior authorisation for the disposal or discharge of radioactive waste to the environment. In England and Wales, responsibility for granting an authorisation rests with the Environment Agency (EA).

The EA formally requires nuclear site operators with radioactive waste discharges to undertake monitoring of the environment around their sites. This monitoring is specified in detail within Compilation of Environment Agency Requirements (CEAR) documents, which accompany the radioactive waste discharge authorisations. CEARs are replacing the former Technical Implementation Documents (TID) where these arrangements were previously described.

However, 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.

Prior to the formation of the EA in 1996, radioactive waste discharge authorisations were granted jointly by Her Majesty's Inspectorate of Pollution (HMIP) and the Ministry of Agriculture Fisheries and Food (MAFF). MAFF became a statutory consultee in the process of determining radioactive waste discharge authorisations upon the formation of the EA. This responsibility was eventually transferred to the Food Standards Agency in April 2000.

The Food Standards Agency has a responsibility for ensuring that any radioactivity present in foods does not compromise food safety and to check that any public exposure as a result of consumers' diet is within European Union dose limits. The monitoring undertaken by the Food Standards Agency is completely independent of the monitoring programmes carried out by the nuclear site operators as a condition of their authorisations to discharge radioactivity.

There has been a gradual transfer of responsibilities for monitoring the non-food pathways from the Food Standards Agency to the EA. Since 1998 the EA has significantly increased its environmental monitoring and assessment to reflect this change.

The responsibilities for independent radiological monitoring undertaken by the EA and the Food Standards Agency are as follows:

- Effluent monitoring	Environment Agency
- Environmental monitoring for non-food pathways	Environment Agency
- Food chain monitoring	Food Standards Agency

There is a Working Agreement between the EA and the Food Standards Agency, which specifies these responsibilities. The objectives of this Agreement are to ensure that in respect of regulation of disposal of radioactive waste:

- Arrangements for consultation during the determination of applications under RSA 93 are efficient and effective (consultation between EA and Food Standards Agency).
- Information is exchanged between the EA and the Food Standards Agency on relevant issues, in particular environmental and food monitoring, radiological assessments and compliance with standards for the protection of the public.

Liaison meetings between the two Agencies are held twice a year. These meetings facilitate the smooth running of the monitoring programmes to consistent standards and allow for the discussion of relevant issues.

The Nuclear Installations Inspectorate (NII) independently monitors direct radiation at nuclear sites. The results are taken account of in critical group dose assessment undertaken by the EA.

5.2. Radioactive discharge authorisations

5.2.1. Certificates of authorisation

The disposal of radioactive waste from nuclear establishments in England and Wales is permitted, subject to limitations and conditions set out in Certificates of Authorisation granted by the EA under RSA 93. The Certificates of Authorisation determine the conditions and limits for the amount of radioactive substances discharged in solid, aqueous or gaseous form from each licensed site. The limits are expressed both as gross alpha and beta values and as nuclide-specific values that may be discharged over specific periods of time. Standard conditions with respect to record keeping, the use of best practicable means to reduce the activity in all the waste discharged, and the means of discharge are included in all authorisations. Also included are provisions for monitoring programmes, including environmental monitoring and analysis. Failure to comply with these authorisations is an offence under Section 32 of the Act.

5.2.2. Independent verification

The EA requires operators of nuclear licensed sites to provide samples of their liquid effluents for independent radiochemical analysis. The results provide checks on site operators' returns and insights into their quality assurance (QA) procedures and analytical techniques. The sampling consists of either single spot samples or monthly or quarterly bulked samples as appropriate. The contractor who currently undertakes the independent radiochemical analyses on effluents for the EA is the National Radiological Protection Board (NRPB) at its laboratories in Glasgow, Scotland, using analytical methods most of which are accredited by UKAS. Collection of spot samples for the EA is in most cases witnessed by NRPB staff. Samples are sealed to ensure the chain of custody.

5.2.3. Discharge limits applicable to the Sellafield site

Current Authorisations for the disposal of aqueous (document AF2248) and gaseous waste (document AF2256), both under RSA 93, came into effect on 17 January 1994.

Notices of variation, modifying discharge limits and other conditions, were enforced on:

- 31 March 1996 (document AP2081 for gaseous waste)
- 1 January 2000 (document AX5495 for aqueous waste / document AX3061 for gaseous waste)
- 15 December 2000 (document BJ8090 for aqueous waste)
- 20 December 2002 (document BT9496 for aqueous waste)
- 23 July 2003 (document BV2344 for aqueous waste)

The currently applicable discharge limits are detailed in Appendix 7.

Note: on 1 October 2004 the authorisation listed above were replaced by a single integrated authorisation (document BX9838).

6. MANAGEMENT OF RADIOACTIVE DISCHARGES

6.1. Introduction

This section deals with the management of radioactive discharge control. Without being exhaustive, a general overview of relevant matters is presented. The information that is provided here draws heavily on documentation presented to the verification team concerning Sellafield Site Procedures (quality assurance and control documents).

At the time of the verification activities the Sellafield site was in a state of transition between the current authorisation for discharges and a proposed one, the proposed modifications having significant implications in terms of management practices, documentation and reporting.

It is recommended that the Environment Agency keep the European Commission's Radiation Protection Unit updated on this transition as the process progresses.

6.2. Aqueous discharges

The management of radioactive aqueous waste is defined in a Code of Practice (CoP) document. This CoP, also known as Sellafield Site Procedure (SSP) 2.01.05, supports the requirements of SSP 2.01 'Compliance with the Sellafield Integrated Certificate of Authorisation for Disposal of Radioactive Waste'. SSP 2.01 ensures that the 'Certificate of Authorisation (CA) for Disposal of Radioactive Waste from the premises of BNFL at the Sellafield Site' and its accompanying document, the 'Compilation of Environment Agency Requirements' (CEAR), both issued by the EA, are fully implemented on the site.

6.2.1. Objectives and conditions

Basically, the CoP (SSP 2.01.05) sets out the procedures and arrangements for the management of radioactive aqueous effluent discharges to sea, in relation to EA requirements.

The main requirements of the CA are:

- Radioactive aqueous effluents must only be discharged to sea via the sea pipelines and the factory sewer.
- Best Practicable Means (BPM) must be applied to all aqueous effluent discharges to sea to exclude suspended solids, to exclude non-aqueous liquids and to control the radioactive inventory of the discharge.
- Radioactive discharges must not exceed any of the site weekly limits, Rolling Annual Limits or Rolling Quarterly Notification Levels (RQNL).
- If a discharge exceeded its RQNL, the EA shall be provided with written details, as specified in the CA.
- All radioactive discharges to sea shall be measured using methods agreed with the EA.
- Whenever modifications to plant, process or design of new plant are performed, consideration must be given to either segregating liquid effluent discharges to sea or providing separate sampling and monitoring arrangements.

More in particular, the CoP (SSP 2.01.05) sets out the procedures and arrangements for the management of radioactive aqueous effluent discharges, in compliance with:

- SSP 2.01.01: 'Arrangements for Compliance with the Integrated Certificate of Authorisation for Disposal of Radioactive Waste'.
- SSP 2.01.02: 'Techniques for Determining the Activity of Radioactive Waste Disposal made under the Integrated Certificate of Authorisation'.

- SSP 2.01.10: 'Management of Discharge Records for Aerial and Liquid Effluents and Environmental Monitoring and Assessments'

6.2.2. Procedures and arrangements

CoP (SSP 2.01.05) details, between others, the following procedures and arrangements:

- Management of liquid effluent sampling arrangements. The individual Accountancy Point Plants (APP) [(2)] take liquor samples and measure the discharge volume of the effluent prior to discharge. The liquor samples are submitted to Analytical Services for analysis, as defined in SSP 2.01.10. Discharge information necessary for the calculation of discharge activity is forwarded to Environmental Monitoring and Assessment (EMA). It is the responsibility of the Liquid Effluent Co-ordinator (LEC) within each operating unit to oversee these processes.

  Analytical Services bulk the samples into weekly, half-monthly, monthly and quarterly bulks, as specified in SSP 2.01.02. Samples are analysed for the radionuclides defined in SSP 2.01.02, using corresponding Quality Assured Analytical Methods (QAAM). Analytical Services report the results obtained to EMA within the timescale defined in SSP 2.01.02. Results obtained are also reported to the LEC for quality assurance purposes. Results are kept in an electronic database called SLIMS (Sellafield Laboratory Information Management System), run by Analytical Services.

- Records and forms. All necessary records and forms associated with recording and reporting of discharges of liquid effluent to sea are defined in SSP 2.01.10.

- Management of liquid effluent discharge data. EMA calculate the radioactive inventory of liquid effluent discharges to sea, as described in SSP 2.01.10. Eventually all relevant discharge information, analytical results and calculations are stored in the EAGLE (Environmental Analysis of Gaseous and Liquid Effluents) database.

  EMA compile discharge reports and sends these to the Liquid Effluent Control Working Party (LECWP) and the Low Active Effluent Management Group (LAEMG) Shift Co-ordinator. The former sets and reviews discharge trigger levels. The latter compares the actual discharge with the corresponding discharge trigger level and will inform LECWP and corresponding APP if the trigger level is exceeded.

  Statutory reports are produced in a format and to a timescale specified within the CEAR document and sent to the EA (and other persons nominated in the CEAR).

- Trending and review of discharge data. The APP Manufacturing Managers are responsible for trending the liquid effluents from their plant and identifying abnormalities that could result in a discharge trigger level being exceeded. The Manufacturing Managers are assisted in this by the LEC. It is the LEC's responsibility to be the first point of contact for liquid effluent discharge issues within his/her area, to represent his/her area at the LECWP meeting and to provide estimates of discharges in the event of lack of measured data. Where abnormal trends are identified, these must be reported to the LAEMG Shift Co-ordinator and/or LECWP for assessment of their impact on site discharges. Where appropriate, action must be undertaken to avoid recurrence of such trends.

- Use of BPM. Compliance with the CoP ensures demonstration of BPM when discharging liquid effluent to sea. BPM are defined in SSP 2.01.03 'Management of Radioactive Waste using Best Practicable Means'.

- Local procedures. Every APP must have procedures and written instructions in place for:

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2 The major liquid APP are: EARP, SIXEP, SETP, THORP C-14 Removal Facility, THORP Receipt and Storage (pond) and THORP Feed Pond.

i. Defining the Conditions For Acceptance (CFA) for liquor receipts in their plant.
ii. Sampling liquid effluent discharges to sea.
iii. Despatching the liquor samples to Analytical Services.
iv. Measuring the volume of liquid effluent discharged to sea.
v. Reporting the discharge volumes to the LAEMG and EMA.

- Audit and review. All key APP must be reviewed at least annually. Such reviews are performed by the LECWP and are reported to the Discharge Control Group (DCG).
- Responsibilities. All actors participating in the daily control of discharges are listed and their respective responsibilities defined.
- Training. The necessary qualifications for a LEC and a LAEMG Shift Co-ordinator are described.

6.3. Gaseous discharges

The management of radioactive gaseous waste is defined in a Code of Practice (CoP) document. This CoP, also known as Sellafield Site Procedure (SSP) 2.01.04, supports the requirements of SSP 2.01 'Compliance with the Sellafield Integrated Certificate of Authorisation for Disposal of Radioactive Waste'. SSP 2.01 ensures that the CA and the CEAR are fully implemented.

6.3.1. Objectives

Basically, the CoP (SSP 2.01.04) sets out the procedures and arrangements for the management of radioactive gaseous effluent discharges, in relation to EA requirements.

More in particular, the CoP (SSP 2.01.04) sets out the procedures and arrangements for the management of radioactive gaseous effluent discharges, in compliance with SSP 2.01.01, SSP 2.01.02 and SSP 2.01.10.

6.3.2. Procedures and arrangements

The CoP (SSP 2.01.04) details, between others, the following procedures and arrangements:

- Management of aerial effluent sampling arrangements.

i. Management of sampling systems

For each scheduled stack, it is the responsibility of the Head of Manufacturing (HoM) to ensure that sampling systems are provided as required for compliance with SSP 2.01.02 and that gaseous samples are taken and analysed in compliance with the CA. The HoM is assisted by a Stack Co-ordinator (SCO).

Equipment for aerial sampling has defined routine and breakdown maintenance regimes including provision of spare parts.

Sample representativeness of each sample point is reviewed every two years, or if plant ventilation characteristics are significantly changed or modifications have been carried out to the sample line. The methodology must be agreed by the Aerial Effluent Control Working Party (AECWP) and the results of any testing carried out is appended to the stack manual.

ii. Stack manual

It is the responsibility of the SCO to ensure that a sampling manual detailing each statutory sampling point is in place (as required by SSP 2.01.02). The contents of this manual encompass, between others: system specification, technical data, operating parameters of the system, maintenance and measuring equipment calibration procedures.

iii. Routine sample media change.

Controlled procedures must be in place, detailing the arrangements for sample media change and any associated bulking arrangements. The SCO must ensure that sample media are stored correctly and despatched to Analytical Services. Samples must be sent under a change of custody form, with a copy retained by the SCO. Filter media must be labelled and sent in accordance with Analytical Services Conditions for Acceptance. Any loss or damage of sample media must be reported immediately to the SCO.

iv. Non routine sample media change

Where additional samples are required by EA as detailed in the CEAR, appropriate arrangements must be made by the SCO for taking and despatch of these samples to Analytical Services. Analytical Services should then make appropriate arrangements to despatch these samples to the EA's specified contractor.

v. Sample analysis and analytical results

Samples are analysed for the radionuclides defined in SSP 2.01.02, using corresponding Quality Assured Analytical Methods (QAAM). Analytical Services report the results obtained to EMA within the timescale defined in SSP 2.01.02. Results obtained are also reported to the Stack Co-ordinator for quality assurance purposes. Results are kept in an electronic database called SLIMS (Sellafield Laboratory Information Management System), run by Analytical Services.

vi. Failure of sampling equipment or loss of sample media

In order to reveal sampler failure, sampling systems must have instrument fail alarms in place that inform the local Plant Control Room, with an appropriate response to the alarm captured in local procedures. Where instrument failure alarms are not practicable, local arrangements must be in place to perform routine checks of sampling equipment functionality, on at least a daily basis.

- <u>Management of aerial effluent discharge data</u>.

The SCO must make the necessary arrangements for the following data to be reported to EMA:

i. Sample volume data.
ii. Sample on/off date and times.
iii. Liquid volume data (liquid samples from bubblers or scrubbers).
iv. Stack flow volume data (for on line measurements).
v. Discharges from on line monitors required for accountancy reporting.
vi. Throughput figures for those stacks with throughput related discharge limits.

It is the responsibility of EMA to collate the analytical results as reported via SLIMS and the stack and sample data as provided by the SCO.

- <u>Management of aerial effluent discharge monitoring arrangements</u>.

Discharge monitors provide real time discharge level data and high radioactivity alarm warnings of abnormal discharge levels. Radioactivity being discharged from all scheduled stacks must be continuously monitored for alpha and/or beta emitters. On line monitors for other nuclides are installed where required (identified by plant design / plant safety case).

Any changes to the arrangements for on line monitoring must be covered by a plant modification proposal document, and must be assessed by the AECWP before approval.

Discharge monitors must have high activity and instrument fail alarms enunciated in the local Plant Control Room. Stack (activity) alarms are subject to annual review to ensure that alarm levels continue to be set appropriately.

- Trending and review of discharge data.

The SCO is responsible for the trending and review of discharge data in order to identify any abnormal trends at an early stage so that any potential breach of a trigger level or authorised limit is identified and managed correctly.

The Manufacturing Manager must routinely carry out (at least on a three monthly basis) a review of discharge data and associated trends. To that effect the SCO presents a local aerial effluent discharge report which captures the following data for review:

i. Trends in accountancy discharges against trigger levels and authorised limits.
ii. Any abnormal trends in initial counts data.
iii. Trends in particulate and volatile discharges based on sample results.
iv. Ongoing investigations into any abnormal discharges or discharge trends.
v. Any failure in sampling equipment or loss of sample media.
vi. Any discharge estimates produced.

Following authorisation at the local review, the report is distributed to the HoM and to the chairman of the AECWP.

- Audit and review.

Approved local procedures must be reviewed annually by the SCO to ensure that the responsibilities in SSP 2.01.04 are being adhered to. The audit must be carried out by independent representatives and managed by the chairman of the AECWP.

7. VERIFICATION ACTIVITIES - RADIOACTIVE DISCHARGES

7.1. THORP – aqueous discharges

The verification team was given an overview presentation of the pond systems and C-14 removal facility process prior to proceeding onto plant floor.

7.1.1. Sampling and monitoring systems – verification activities

The verification team visited:

- The systems in place to control the discharge of liquid effluent arising in the Receipt and Storage (R&S) and Feed Pond (FP) purge. The effluent is continuously discharged to the Break Pressure Tank (BPT) prior to disposal to the Irish Sea. A daily proportional sample is taken for retrospective accountancy purposes. Sample point reference SP2275.
- The systems in place to control the discharge of liquid effluent arising in the C-14 supernatant stock tank of the C-14 removal facility. The effluent is discharged (after sampling and authorisation) to the BPT prior to disposal to the Irish Sea. Sample point reference SP2241.

7.1.2. Sampling and monitoring systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as defined in the regulatory obligations.

It was noted that:

7.1.2.1. Receipt and Storage (R&S) pond and Feed Pond (FP)

- The pond water is continuously circulated via an overflow weir at the neck of the pond. Of this re-circulation approximately 1000 m^3 are purged per day (about ⅓ of the re-circulation). One m^3 of the daily purge (1/1000) is proportionally sampled into a sample vessel (sample point SP2275). The remaining purge is continuously discharged to the BPT. On a daily basis the sample received in the sampler vessel is agitated for one hour to ensure that the sample taken is homogeneous.
- A hard-wired gamma detector sitting on the discharge line to the BPT ensures on-line monitoring. If triggered by a reading exceeding 300 Bq/ml the discharge is shut down automatically. A reading for this monitor could be observed in the local control room.
- Quality control was implemented through a compilation of comprehensive written operational procedures: working instructions OI/01/69 and OI/01/73 (amongst others). These instructions detail the sampling and discharge actions that are required and the information that is to be recorded.

7.1.2.2. C-14 removal facility

The C-14 removal facility is designed to separate C-14 from the caustic liquor discharged from the dissolver off gas caustic scrubber (DOG). This is carried out by precipitating the C-14 by addition of barium nitrate to the liquor. The resulting barium carbonate slurry is settled, decanted and washed. The aqueous effluent is collected in batches, sampled and discharged to sea via the BPT.

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as defined in the regulatory obligations.

It was noted that:

- Discharge control is performed at sample point SP2241 on the supernatant stock tank.
- Discharge to the BPT can only be authorised if the contents of the stock tank meet the conditions for acceptance (CFA). Only a DAP (duly authorised person) can sign the authorisation to discharge.
- The discharge volume is limited to 30 m^3 per day (in one batch discharge). Alpha activity restrictions are set at 0.2 GBq/day (peak value) and 0.5 GBq/month. Beta activity restrictions are set at 50 GBq/day (peak value) and 100 GBq/month. Uranium contents must be less than 32 g per batch.
- Samples are filled into pre-labelled plastic bottles that are subsequently sealed. However, the identity of the operator carrying out the sampling activity is not registered. Health Physics monitors the samples to ensure that they are suitable for transport before Head End Chemical personnel transfer the samples to a store from where analytical services personnel collect them for transfer to the analytical laboratory. The chain of custody is thus not fully traceable.
- The definitive accountancy of the activity discharged is performed retrospectively through a monthly analysis of a bulk sample.
- Quality control was implemented through a compilation of comprehensive written operational procedures: working instructions HE/2241/0A, HE/2242/0A, OI/02/226, OI/02/227 and OI/02/228 (amongst others). These instructions detail the sampling and discharge actions that are required and the information that is to be recorded.

Furthermore, in a discussion regarding the calibration of the sampling unit, it emerged that an experiment was being planned to verify that the sampler is taking representative samples. The experiment will consist in testing whether full homogenisation of the supernatant stock tank is achieved prior to sampling.

7.1.2.3. Conclusion

The verification team considers the monitoring and sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory.

The verification team notes that discharges of liquid radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

However:

Noting that the operators performing the sampling procedures are generally not identifiable, the verification team recommends, with a view to improve quality assurance, that the traceability of responsibility within the chain of custody be reviewed.

Noting that the accountancy sampler for the C-14 removal facility is planned to undergo a re-calibration exercise to verify that it is taking representative samples, the verification team recommends the Environment Agency to consider reviewing whether the liquid discharge accountancy samplers present on site would not benefit from a similar exercise.

7.2. THORP – gaseous discharges (main stack)

The verification team was given an overview presentation of the THORP processes and stack monitoring and sampling systems prior to proceeding onto plant floor.

7.2.1. Sampling and monitoring systems – verification activities

The verification team visited:

- The 5 accountancy discharge ducts [(3)] arriving at the stack from the:
    - i. dissolver off-gas system (DOG)
    - ii. vessel ventilation systems (VV)
    - iii. gloveboxes (GB)
    - iv. cell and cave extract systems (C5)
    - v. C3 extract systems (C3) – this duct provides approximately 95 % of the total stack flow rate
- The sampling systems [(4)] in place on these ducts:
    - vi. Bird and Tole particulate samplers (on all ducts)
    - vii. Maypack iodine (I-129) samplers (on all ducts)
    - viii. Caustic bubblers for H-3 and C-14 (on DOG and VV)
    - ix. Caustic scrubbing columns for Ru-106 (on DOG and VV, redundant systems, one of which on standby)
- The monitoring systems [(5)] in place on these ducts:
    - x. Alpha/Beta monitors (on all ducts and redundant) – moving filter radiometric monitors
    - xi. I-131 monitor (on DOG) – low resolution gamma spectrometry
    - xii. Kr-85 monitor (on DOG) – gamma spectrometry (2 independent sets of detector + electronics)
    - xiii. Ru-106 monitor (on DOG and VV, redundant systems) – low resolution gamma spectrometry

7.2.2. Sampling and monitoring systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling systems as defined in the regulatory obligations (and listed in appendices 5 and 6). The team also verified to its satisfaction that the operational and measurement parameters as described in appendices 5 and 6 were abided by.

It was noted that:

- A comprehensive range of permanently installed monitors and samplers are located in the stack bridge area to serve the five ventilation systems (accountancy discharge ducts) prior to discharge. These systems operate in a continuous mode.
- Power supply backup is provided in the form of batteries giving a one-hour cover. Diesel units are present in case a prolonged power failure would occur.

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3 See appendix 4 for a summary diagram.

4 See appendix 5 for an extensive list of these sampling systems. This list is a summary of the relevant part of the Aerial Effluent Authorisation Implementation document.

5 See appendix 6 for an extensive list of these monitoring systems. This list is a summary of the relevant part of the Aerial Effluent Authorisation Implementation document.

- The monitors and the samplers give both real time discharge information and retrospective accountancy results. The real time information is displayed at the Central Control Room (CCR) only – not locally.
- A scintillation detector is providing Kr-85 measurements on the DOG (the assumption is made that Kr-85 is the dominant beta emitter on this line). Discharge accountancy for Kr-85 is performed by this continuous measurement.
- Health Physics personnel transfer the sample taken for discharge accountancy purposes to the radio-analytical laboratory after having performed a dose-rate screening.
- It takes typically 4 to 6 weeks to obtain results for the accountancy samples. Formal accountancy is retrospective in nature.
- A daily survey of the dose-rate from installed filters is performed with the purpose to detect any possible build-up of activity on the filter medium.
- Quality control is implemented through a compilation of comprehensive written operational procedures: working instructions HP/INST/23 and OI/08/929 (amongst others). These instructions detail the actions that are required and the information that is to be recorded at the time of sample change.
- Alarms that are due to either high activity in the discharge duct or instrument failure are annunciated at the CCR. Operator responses to alarms are defined in specific working instructions. All accountancy ducts are covered by 4 levels of alarm (L1 to L4): these levels are set out in specific quality assurance documents.
- If loss of sample media or instrument malfunction occur then the discharge will be estimated through a calculation based on the average discharge of the previous six months. Similarly calculations are performed when flow data are lost.
- All systems have a programme of scheduled inspection and maintenance. The schedule is controlled by a centralised computer programme (database) that prompts the operator in the CCR whenever a particular system is due for inspection/maintenance (this includes filter changes and flow rate checks). All historical inspection/maintenance details are kept within the computer programme.
- The verification team received a technical file describing the BAI 9300A alpha detector (ZnS scintillator) as well as calibration instructions. This detector is part of the Lab Impex 900 series moving filter radiometric monitors that are present on the DOG, VV, C3 and C5 ducts.
- Discharge accountancy is not performed on the other outlets (C2 and C1 extraction systems). These systems are given the designation of ‘approved places’ and are not discharged through the THORP stack. Examples of C2 and C1 areas are toilet extracts and areas where the potential for contamination is absent. Such ‘approved places’ come under the site-wide discharge limit for approved places. It was however noted that all C2 ducts have monitors installed (see also section 7.3.2).

The verification team considers the monitoring and sampling equipment for gaseous effluents to be adequate and the programme of gaseous effluent sampling to be satisfactory.

The verification team notes that discharges of gaseous radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

7.3. SMP – gaseous discharges

The verification team was given an overview presentation of the SMP processes and discharge monitoring and sampling systems prior to proceeding onto plant floor.

7.3.1. Sampling and monitoring systems – verification activities

The verification team visited:

- The 2 discharge ducts from SMP plant feeding into the THORP main stack.

  Both ducts correspond to the C3 and C5 SMP ventilation extract systems. C3 represents the operating area ventilation whereas C5 represents the glovebox ventilation system. The C3 extract is filtered through a two stage HEPA filter bank before routing to the THORP stack where it connects via a tee with the THORP C3 discharge duct. The C5 extract is also filtered through a two stage HEPA filter bank before routing to the THORP stack in which it has its dedicated flue.

- The monitoring systems present on these ducts.

  Both the C3 and C5 ducts are fitted with duplicate monitors (Lab Impex moving filter paper monitors that continually measure alpha and beta particulate matter - filters are exchanged on a three-monthly basis) to provide real time discharge information, together with volumetric flow measurement devices. The monitors alarm for high activity and instrument failure. Alarms link to the SMP and THORP CCRs. Additionally, and for both ducts, there is an in duct alpha monitor (Harwell 3280) located between the filter banks. Their function is to give early warning of a discharge monitor alarm or the loss of a primary filter bank that may not be detected by the discharge monitor.

- The sampling systems present on these ducts.

  Both the C3 and C5 ducts are fitted with two duplicate samplers (Bird & Tole static filter sampler) that allow retrospective assessment of the activity discharged. Static sample filters are exchanged and initially counted on a daily basis for both ducts. The filters from one of these samplers are bulked on a weekly basis for analysis by Analytical Services (accountancy). The Harwell 3280 monitor filter papers are exchanged on a weekly basis.

7.3.2. Sampling and monitoring systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as defined in the regulatory obligations (summary description of which is given under section 7.3.1 above).

It was noted that:

- A comprehensive range of permanently installed monitors and samplers are present that serve the 2 ventilation systems (accountancy discharge ducts) prior to discharge. These systems operate in a continuous mode.
- Quality control is implemented through a compilation of comprehensive written operational procedures: working instructions HP/INST/05, HP/INST/26, HP/OSG/01 and OI/700/09 (amongst others). These instructions detail the actions that are required and the information that is to be recorded at the time of sample change.
- Alarms that are due to either high activity in the discharge duct or instrument failure are annunciated at the CCR of both SMP and THORP. Operator responses to alarms are defined in specific working instructions.

- All systems have a programme of scheduled inspection and maintenance. The schedule is controlled by a centralised computer programme (database – named TEROMAN) that prompts the operator in the CCR whenever a particular system is due for inspection/maintenance (this includes Lab Impex monitor filter changes and flow rate checks). All historical inspection/maintenance details are kept within the computer programme.
- Upon request by the verification team the operator presented technical drawings that certify the isokinetic design of the C3 and C5 in duct sampling and monitoring nozzles. The operator furthermore provided the verification team with system performance demonstration documents for the C5 Lab Impex system (demonstration during level 2 commissioning, document references SPD861/2/2410 and SPD861/2/4401).
- While monitors are installed on the ducts from SMP and some of these ducts discharge through the THORP stack and have alarm triggers, measurements made by these devices do not contribute to the accountancy of discharge from SMP. In this context SMP is considered to be an ‘approved place’ and is covered by the side-wide authorisation for approved places. Accountancy for such places (including some 80 stacks and open fuel storage ponds on site) is provided through a combination of data from on-site high volume air samplers and modelling. Discharges from approved places account for up to 30% of aerial discharges from the Sellafield site. It was confirmed that the EA might review this practice going forward (see also section 10.1.14 of this report).

The verification team considers the monitoring and sampling equipment for gaseous effluents to be adequate and the programme of gaseous effluent sampling to be satisfactory.

The verification team notes that discharges of gaseous radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

However:

It was noted that up to 30% of the aerial discharges from the Sellafield site are from so called ‘approved places’. It was also noted that accountancy estimates of these discharges are provided for by a combination of data from on-site high volume air samplers and the application of environmental modelling. While this practice is carried out with the approval of the Environment Agency, the verification team recommends that the Environment Agency review the efficacy of this practice.

7.4. EARP – aqueous discharges

The verification team was taken to an EARP meeting room where an overview presentation of the process was given prior to proceeding onto plant floor.

EARP treats by flocculation and ultrafiltration, effluent streams it receives mainly from Magnox operations but also from THORP. EARP handles two classifications of effluent type called ‘bulks’ and ‘concentrates’. Bulks represent low active effluent streams whereas concentrates represent medium active effluents.

At the time of the verification exercise, the plant was in the process of being modified to remove Tc-99 prior to discharge.

7.4.1. Sampling systems – verification activities

Discharges from EARP are batch processes and EARP has three sentencing tanks (also called sea tanks) that have to be sampled prior to discharge to the BPT and from there to Irish Sea. Two of the sea tanks are dedicated to the bulks effluent stream, the third to the concentrates effluent stream.

The verification team visited the sampling systems in place on the three sea tanks.

7.4.2. Sampling systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of the sampling provisions as defined in the regulatory obligations.

It was noted that:

7.4.2.1. Bulks

- For the bulks process only one of the two sea tanks is being filled at anyone time.
- The filling sea tank is spot sampled at various stages for process control purposes (presence of solids, detection of floc breakthrough from ultrafilter failure). Depending on the results of these samples the sea tank's content may be recycled.
- Two final (sentencing) samples of 2500 ml are taken in a glovebox (sample cabinet T-059 – sample point reference SP821). Samples are extracted by a vacuum operated slug lift from the proportional sampler tank (1/1000). A quick analysis provides results that are compared against the daily discharge triggers. After confirming that the results are acceptable the LAEMG Shift Co-ordinator signs the authorisation to discharge. However, if the analysis results indicate that the sea tank is out of specification its contents will be recycled.
- Daily discharge triggers are: 900 m³ volume, 4 GBq total alpha activity and 1 TBq total beta activity.
- Detailed discharge accountancy is carried out retrospectively (bulked on bi-monthly and monthly basis).
- Quality control is implemented through a compilation of comprehensive written operational procedures: working instructions EARP/COI/4S1, /19P and EARP/OI/40P (amongst others). These instructions detail the actions that are required and the information that is to be recorded at the time of sample change.
- No special security arrangements (such as comprehensive tagging of the sampling point) were in place at the T-059 sample cabinet to prevent an operator sampling from the wrong tank. It was however explained that an operator would be experienced enough not to allow this to happen.
- Samples are filled into pre-labelled plastic bottles that are subsequently sealed. However, the identity of the operator carrying out the sampling activity is not registered. Health Physics personnel carry out a dose-rate screening prior to the operator transferring the samples to the radio-analytical laboratory. The chain of custody is thus not fully traceable.

7.4.2.2. Concentrates

- The concentrate sea tank is sampled directly by aspiration following agitation (homogenisation of the content of the tank). This ensures representativeness of the sample taken.
- Three final (sentencing) samples of 150 ml are taken in a glovebox (sample cabinet T-088 – sampling point reference SP831). A quick analysis (total alpha/beta, pH etc.) provides results that are compared against the daily discharge triggers. After confirming that the results are acceptable the LAEMG Shift Co-ordinator signs the authorisation to discharge. However, if the analysis results indicate that the sea tank is out of specification its contents will be recycled.

- Daily discharge triggers are: 300 m^3 volume, 1 GBq total alpha activity and 4 TBq total beta activity.
- Detailed discharge accountancy is carried out retrospectively (bulked on bi-monthly and monthly basis).
- Quality control is implemented through a compilation of comprehensive written operational procedures: working instructions EARP/COI/6S6, /17P, and EARP/OI/27P (amongst others). These instructions detail the actions that are required and the information that is to be recorded at the time of sample change.

7.4.2.3. Conclusions

The verification team considers the sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory.

The verification team notes that discharges of liquid radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

However:

Noting that the operators performing the sampling procedures are generally not identifiable, the verification team recommends, with a view to improve quality assurance, that the traceability of responsibility within the chain of custody be reviewed.

With a view to enhance best practice, the verification team recommends that 'lock and key' security arrangements on multiple sampling ports be implemented for all accountancy sampling points (liquid effluents) throughout site.

7.5. SIXEP – aqueous discharges

The verification team was taken to the SIXEP control room where an overview presentation of the process was given prior to proceeding onto plant floor.

SIXEP is a plant essentially designed for the removal of caesium and strontium from liquid effluent streams it receives mainly from Magnox operations. After treatment the effluent stream is continuously discharged to the BPT prior to disposal to the Irish Sea. A daily proportional sample is taken for retrospective accountancy purposes.

7.5.1. Sampling systems – verification activities

The verification team visited the operations control room and sample cabinet 351/1 (sampling point reference SP1150).

7.5.2. Sampling systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of the sampling provisions as defined in the regulatory obligations.

It was noted that:

- The proportional sampler takes 1/4000 of the effluent stream to the BPT. The discharge sample (two 1000 ml bottles) must be taken from the proportional sampler every 24-hours.

- The daily sample is analysed for total alpha and total beta activity. The twice-monthly and monthly bulk samples are analysed for scheduled radionuclides. For the monthly bulk sample these are: Tritium, C-14, Tc-99 and I-129.
- Quality control is implemented through comprehensive written operational procedures. A copy of operating instruction OR/B331/C2 (version 5, April 1999) was present at the sampling point.
- The level of liquid in the proportional sampler tank is verified every 4 hours. Sample tank level and the flow to sea totaliser are recorded and their correlation checked. Plant operations must be halted if the proportional sampler is not properly functioning.
- A gamma monitor protects the discharge line and prevents high activity discharge by interlock with the discharge pumps. The activity concentration trigger level is set at 714 Bq/ml (or 1000 cps). Once the trigger level is exceeded the discharge automatically shuts down. Upon request the operator provided the verification team with a document describing the technical specifications of the gamma detector.

The verification team considers the monitoring and sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory.

The verification team notes that discharges of liquid radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

7.6. SIXEP – gaseous discharges

7.6.1. Sampling and monitoring systems – verification activities

The verification team visited the sampling and monitoring provisions on two of the four discharge ducts into the SIXEP stack: sample points 997 and 998 respectively controlling vessel ventilation and sample cabinet ventilation. Sample points 996 and 999 respectively controlling building/cell ventilation and lab ventilation were not visited, installed equipment being similar.

7.6.2. Sampling and monitoring systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of the monitoring and sampling provisions (at sampling points 997 and 998) as defined in the regulatory obligations.

It was noted that:

- Both ducts are fitted with a Bird & Tole static filter sampler that allows retrospective assessment of the activity discharged. The sample filters are exchanged every week and bulked on a monthly basis for analysis by Analytical Services.
- Both ducts are fitted with duplicate monitors (Lab Impex moving filter paper monitors that continually measure alpha and beta particulate matter) to provide real time discharge information, together with volumetric flow measurement devices. The monitors alarm for high activity and instrument failure.

The verification team considers the monitoring and sampling equipment for gaseous effluents to be adequate and the programme of gaseous effluent sampling to be satisfactory.

The verification team notes that discharges of gaseous radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

7.7. SETP – aqueous discharges

Prior to proceeding on site, the verification team was given an overview presentation of the SETP facility.

Basically SETP is a conditioning facility preparing liquid effluents chemically for discharge (pH mainly) and it has no decontamination factor as such: wastes are neutralised and remaining solids removed (strainers and a hydrocyclone centrifuge separator). Once the effluent has been conditioned it is delivered to one of three sea tanks (2500 m³ each) where it is sentenced before discharge to the BPT and final disposal to the Irish Sea.

A hard-wired trip on the sea tank discharge route will be activated if a high gamma activity (>7500 cps) is detected in the discharge line. This trip will stop the duty discharge pump and close the associated discharge valve.

7.7.1. Sampling and monitoring systems – verification activities

The verification team visited the operations control room and sample cabinet T5002 (sampling point reference SP 3250).

7.7.2. Sampling and monitoring systems – verification findings

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as defined in the regulatory obligations.

It was noted that:

- There is one proportional sampler located on top of each sea tank. Each sampler consists of a series of slotted weirs which splits the treated effluent stream in such a manner that a small portion (1/2720) is derived to a sample tank (stirred vessel of 2 m³), whilst the bulk of the effluent flows into the sea tank.
- Samples are taken from a sample glove box containing the three sampling points – one for each of the sea tanks. The sampling points are locked and the operator will only take the key for the tank to be sampled thus reducing the risk of sampling the wrong tank.
- Sample bottle labels and custody transfer sheets (for Health Physics) were demonstrated. However, the identity of the operator carrying out the sampling activity is not registered. The chain of custody is thus not fully traceable.
- After filling of the sea tank two 1000 ml samples are taken from the sample tank and submitted for analysis. Before taking a sample the sample tank is stirred and re-circulated, this ensures homogenisation of the effluent and representativeness of the sample taken.
- On receipt of sample results the sea tank activity content is calculated. An authorisation to discharge must be obtained from the LAEMG Shift Manager. Accountancy data are received retrospectively.
- It is a requirement of the formal discharge authorisation that SETP sea tank discharges are made within a tidal pumping window. This window opens four hours before high tide time and closes four hours after high tide time.
- When a sea tank discharge is completed its associated sample vessel must be emptied and washed out before the sea tank can be refilled.

- One of the parameters continuously monitored by the control room is the absence of deviation in the proportionality between sample volume collected (in the sample tank) and the filling level of the sea tank. A deviation will indicate a malfunction of the proportional sampler. At a pre-set degree of deviation the filling of the sea tank will be automatically interrupted.
- Quality control is implemented through compilation of comprehensive written operational procedures: operating instructions SETP/OI/62 and SETP/OI/54 (amongst others).

The verification team considers the monitoring and sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory.

The verification team notes that discharges of liquid radioactivity are monitored in accordance with the Certificate of Authorisation and the related Implementation Document.

However:

Noting that the operators performing the sampling procedures are generally not identifiable, the verification team recommends, with a view to improve quality assurance, that the traceability of responsibility within the chain of custody be reviewed.

8. VERIFICATION ACTIVITIES – EFFLUENT LABORATORY (ANALYTICAL SERVICES)

8.1. Introduction

The verification team was given an overview of the laboratory facilities before proceeding to witness the procedures and instrumentation.

The laboratory holds accreditation for most of its procedures from UKAS and has been accredited since 1991. It also has been recently accredited to ISO17025 (except for the part that deals with interpretation of results).

All plants sending samples to the laboratory are treated as clients. Under the quality system in force, instead of contracts with clients, there is a sampling schedule that is followed.

All samples, upon reception are assigned a unique identifier known as LSN (Laboratory Sample Number).

8.2. Verification activities

The verification team visited the laboratory where it checked:

- Sample management, including the presence of associated working instructions.
- The adequacy of measurement systems, including quality control procedures.
- Document control procedures (data management and filing systems).

The verification also performed spot-checks on randomly chosen historical samples in order to verify the data transmission chain between initial measurement of the sample and final reporting to the competent authority.

8.3. Verification findings and recommendations

8.3.1. Sample reception

Samples are received into the laboratory via two entrances. The first is via an alarmed port in the 'dispensary'. The Health Physics personnel place a sample with its custody documentation into a chute and close the door on their side. A signal is sounded in the dispensary until the sample is received into the laboratory. The doors on the chute can only be opened when the other is shut. The sample is taken and registered in a computer, which is close at hand. If documentation has to be returned, it is placed back in the chute for Health Physics personnel to retrieve it. The sample is assigned an LSN when registered in the computer.

There is a second sampling reception area that receives samples from THORP. These samples are placed in a pigeon hole arrangement in the 'laundry' which is outside the main laboratory building but in close proximity to it. When a sample is deposited in the laundry for analysis, the relevant duty officer in the laboratory is paged to collect the sample.

While visiting the dispensary, the verification team witnessed a sample being received into the hatch and registered in the computer. The sample was taken away for analysis to the 'shifts' laboratory that carries out the rapid turn around analysis of total alpha/beta and an initial gamma measurement.

The sample storage area in the dispensary was inspected. The facility is kept under lock and key. Samples are signed into the storage area and residuals are kept for 2 months before being discharged. Depending on the sample schedule, samples are bulked weekly, monthly, quarterly and each of these has prescribed retention times. Where required, samples are stabilised with acid.

The verification activities performed do not give rise to a specific recommendation.

8.3.2. Sample preparation

Liquid samples are bulked in a proportional way and the proportions are worked out on the basis of the actual discharge over a particular period. A schedule for discharging was viewed which gave the discharges for a particular plant and the personnel described how the volumes from each were estimated. This schedule would change subject to the bulking period. Discharge volumes are sent to the EMA and the EMA sends this data to the laboratory to aid them in the bulking process. Such instructions are filed and archived.

There are two laboratories, adjacent and connected to each other that are used for sample preparation for gamma analysis. Samples for gamma analysis are prepared by pipetting. The volumes used are 5, 10 and 50 ml. Flat bottom cylindrical plastic bottles are used as counting containers. Sample containers are clearly labelled.

Samples are sent to the counting laboratory with a sample work sheet. It was noted that the analyst that prepares the sample is not recorded on either the sample or the documentation.

The sample work sheet is returned to the laboratory from the counting laboratory with the results attached. The results are then entered by hand into the Laboratory Management System (LIMS) where they are electronically signed and counter-signed.

All of the paperwork and electronic records for sample LSN 881834 were viewed and all were observed to be in order. The procedure for the preparation of samples for gamma analysis was readily to hand in the laboratory and the instructions appeared to be clear and concise.

It was observed that there is a protocol for the exchange of samples between plants and the laboratory. However, for the subsequent analysis and reporting the traceability of activities to individual operators or analysts is not always evident. It is recommended that the traceability of the chain of custody from the sampling point to the reporting of data be reviewed.

8.3.3. Gamma counting laboratory

The gamma laboratory is divided between two interconnecting rooms. There are four high-resolution detectors in operation. Two of these detectors have low energy capacity. One new system has not been brought into operation yet and two systems have been taken out of operation. One of these, a lithium drifted germanium, seems to have heated up with the resultant disintegration of resolution and efficiency. All of the detectors are liquid nitrogen cooled. The detectors are a mixture of Ortec and Canberra supplies.

It was noted that there are no balances to measure the level of nitrogen in the dewars. Detectors are filled weekly but there is no formal schedule and no notebook/record of who last filled them and when they were filled.

There is a local area network in each room with two detectors sitting on each in a mirror type arrangement.

Samples enter the laboratory through a designated door and are placed on a table in the reception part of the room sitting on the related paper work. A sample was observed being logged onto the computer system and placed on the detector. The software is Canberra using the VMS operating system.

There are end caps for each of the detectors for positioning sample bottles except for the 50 ml samples which are positioned by hand. Two of the detectors have graded shielding and two have ordinary lead shielding.

There was a complicated method of registering the samples into the computer. Even though a sample had a unique LSN, it was assigned a new number that was a combination of the date and the detector number. This number is recorded against the LSN and though cumbersome, appears to be traceable.

There are no formal counting times/criteria for samples but typically statutory (accountancy) samples are counted for 40 minutes. However it was noted that it is the policy of the laboratory not to report less than values – they always report a number – and force a result no matter how that number might be represented in terms of uncertainty. Procedures for the gamma lab were readily accessible. Samples that are measured and are found to have a dead-time of >2% are rejected and sent back to the laboratory for re-dilution.

A sample was picked and the paper trail followed. LSN 849309 that was then given a counting laboratory number 1sep034008 (counted 1st September). No electronic record of the spectrum was kept but a print out of the results was located in an archive box (boxes are labelled and then archived). The QA charts for the period were reviewed and all appeared to be in order.

The laboratory only measures filters from 3 points on the site B6, B204 (4 samples) B303 (salt evaporator), all other filters are sent off-site to the Westlakes laboratory for analysis (e.g. all other gas type samples)

It was noted that the effluent laboratory has a policy of always reporting a positive result for its gamma analysis regardless of the magnitude of the errors. It is recommended that this practice be reviewed in line with international guidance on uncertainty estimation.

8.3.4. Quality assurance in the gamma counting laboratory

The QA charts for the detectors are paper copies. The operator measures a mixed liquid standard (Co-60, Ba-133 and Cs-137) each morning and records the FWHM and total counts under each peak for each detector before proceeding to use the detectors. Generally, detectors are not used to measure samples overnight but backgrounds are counted for each detector and the background files are updated each morning.

It was stated that the initial calibration was carried out with either a mix of standards or a mixed energy standard supplemented with individual radionuclides such as Co-60 and Cs-134 that would provide inherent summation correction factors.

It was stated that zeolite filters would require absorption corrections at low energy and this would have been carried out in an initial calibration of the system – however the paper trail was not to hand.

The laboratory has a service contract with Canberra for the software on a best 'endeavour basis'. Some of the components on the old VAX are difficult to replace. The laboratory is coming under pressure in this area and there are advanced plans to update the software and supporting computer hardware. There is no service contract for the gamma detectors.

Detector manuals were not available except for one detector. No detector had undergone an initial calibration in the service time of the routine laboratory operators. This was seen as presenting a challenge for staff when new detectors are brought on line. No procedures exist for initial calibration except for a schematic that is acknowledged to be short on detail (QAAM 51).

A separate laboratory prepares all of the standards used in the laboratory (Standards Laboratory). It was not possible to find any records of the standards currently used (certificates) in preparing the initial detector calibrations as they were not kept at the time.

The operator confirmed that the laboratory does not participate in the measurement of intercomparison exercise samples. It was stated that it was difficult to find such a sample of sufficient activity for comparison purposes. However it was noted that many of the samples that the laboratory measures, by definition, do not have very high activities. Furthermore the analysts did not seem to fully appreciate the value of such exercises pointing to the importance of internal checks.

The EA also measures some of the same samples as the laboratory and results were compared on an annual basis. This type of comparison has not taken place for a couple of years and it is unclear if these results of such comparisons have filtered down to the actual laboratory operators. This exercise, while useful is not a substitute of a formal multi laboratory exercise.

The laboratory does not have an internal known sample to measure frequently other than that provided by the standards laboratory.

For two weeks following measurement, samples are placed on a table in the counting room in proximity to the detectors. The operators showed a health physics activity survey of the counting room which had been carried out the previous day. All parts of the room measured showed an activity rate of <5 cps except in the vicinity of the table where the count rate was 200 cps.

It was noted that sample management practices within the gamma measurement laboratory give rise to elevated count rates in the vicinity of gamma detectors. It is recommended that the sample management practices be reviewed with the aim to reduce the possibility of fluctuations in detector background and the risk of contamination in the laboratory.

It was noted that the while the laboratory holds accreditation from the UK accreditation authority (UKAS), it does not participate in inter-laboratory proficiency tests. With a view to maintaining high levels of quality assurance and control it is recommended that the laboratory regularly participate in such tests.

It is further noted that the comparison of independent EA effluent monitoring results with operator effluent results was halted during 2003 due to staff shortages. It is recommended that the EA ensure that this comparison activity resumes.

8.3.5. Chemistry laboratory

8.3.5.1. Technetium-99

An operator was appointed to demonstrate the Tc-99 procedure. The first item checked and verified was that the operator was trained on the procedure and her training record was up to date.

In outline the procedure involves spiking the sample with Tc-99m, solvent extraction into chloroform, back extraction into tetrapropylamonium hydroxide, then back extraction into hydrochloric acid and then extraction into liquid scintillant with trioctlyamine. Both a blank sample and a reference amount of Tc-99 are brought through with each batch of analysis. Recovery is determined with a gamma measurement relative to a preserved aliquot of Tc-99m reserved at the time of initial spiking.

Samples are set a side for 5 days prior to measurement by LSC to allow the Tc-99m tracer to decay away so that it would not interfere with the measurement. Samples are colour coded on top – blacked out when measured. Liquid standards are sealed with para-film. Control charts are kept as paper records and are updated regularly. The general paper trail traceability was evident.

It was stated that in recent times more Tc-99 analysis was being performed by mass spectrometry but time did not allow to view this machine or technique.

The written procedure for Tc-99 was readily available in the laboratory.

8.3.5.2. Plutonium-238, 239, 240 & 241

The plutonium technique was designed both to allow for the determination of the alpha emitting nuclides (Pu-238, 239, 240) together with the beta emitting isotope Pu-241.

In outline the procedure involves spiking the sample with a known quantity of Pu-236 acting as a yield monitor, an initial lanthanum fluoride precipitation, the precipitate is retaken in acid and followed by a lanthanum hydroxide precipitation. Again the precipitate is retaken in a known volume of acid and the sample is sent for Am-241 determination by gamma spectrometry. The chemical yield is determined by a relative measurement to the activity of a reference aliquot of Am-243 tracer.

When the sample arrives back from the gamma lab, the plutonium isotopes are brought to the +4 state with the addition of sodium nitrate. A clean up ion exchange resin is used and the plutonium is eluted in HCl/HI solution. The plutonium is extracted into a benzene solution of Hyamine 1622 and 1 ml of this is evaporated onto a stainless steel disc. The disc is then ignited in a Bunsen flame to remove organic residues and to fix the plutonium activity.

The disc is then measured by alpha spectrometry and the relative proportions of each of the alpha emitting nuclides present is recorded as well as the total count in the full window.

From the qualitative alpha measurement the proportions of each of the alpha emitting radionuclides to the total alpha count is recorded. The other portion of the sample is then measured by liquid scintillation counting using alpha beta separation. The total alpha is recorded and the proportion due to the tracer, Pu-236, is known from the qualitative alpha measurement. These can be compared then with the expected number of counts for Pu-236 if 100% chemical recovery were achieved thus providing an estimate of the actual chemical yield for plutonium.

In turn the activities of Pu-238 and Pu-239, 240 can be determined using their relative percentages to the total from the alpha scan and the chemical yield determined by LSC. Pu-241 can also be determined using the chemical yield and a separate efficiency calibration for Pu-241 in the low energy LSC window.

The operator recognised that one of the inherent problems with this methodology is achieving consistently good alpha spectra from the evaporated samples to reduce the tailing and hence the error on the yield and activity determinations. He suggested that the laboratory was considering moving to source preparation by electro-deposition that offered the prospect of enhanced consistency in resolution and obviates the need for recourse to chemical yield determining the alpha activities.

The current methodology could be further hindered if other alpha emitting radionuclides of uranium or americium succeeded in coming through the chemistry.

The operator uses Pu-236 as a tracer that has a higher energy than the plutonium isotopes being determined and can tail back into the Pu-238 region when spectral resolution is poor. Pu-242 is an alternative yield monitor but emits alpha’s to the low energy site of the other Pu alpha emitters. The operator expressed the view that the laboratory was thinking also in moving towards the use of Pu-242 as a yield monitor.

The verification activities performed do not give rise to a specific recommendation.

8.3.6. Instrumentation in the counting laboratory

There were 8 alpha detectors in use – all passivated ion implanted or ‘pips’. Twelve other detectors in a 12 chamber arrangement were present in the laboratory but had not yet been brought into commission.

A number of sample spectra were viewed and the resolution on the three were better than one might have anticipated. The operator indicated that these were the exception rather than the rule and that it was his intention to move the laboratory towards electro-deposition.

The team went to see the LSC counters of which there were two: Packard 2200 CA and 3100 TR. These were in a separate room which was undergoing some refurbishment. They were together with 1 Tennelec gas flow proportional counter, 2 Tennelec alpha scintillation counters and 1 Tennelec Geiger-Müller counter; all with automatic sample changes.

The verification activities performed do not give rise to a specific recommendation.

8.3.7. QA documentation

Some time was spent going through the QA documentation, the quality manual, the internal audit schedule; the UKAS non compliances; internal non compliances and the minutes of the last management review. Records were well kept and in order.

Randomly chosen laboratory source documents (sheets with measurement results, manually or computer generated) where audited to verify the implementation of related working instructions and to verify the robustness of the link between sample number, sampling date and measurement result; this verification activity did not yield any shortcomings.

The verification activities performed do not give rise to a specific recommendation.

9. THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

9.1. Introduction

9.1.1. Aims

One of the conditions of the authorisation to discharge radioactive effluents and wastes is that an environmental monitoring programme must be carried out to determine the effects of these discharges on the environment. The primary purpose of the Environmental Monitoring Programme (EMP) is to monitor the safety of the general public and critical groups. The EMP also provides reassurance that permitted discharges are estimated correctly and that unusual discharges to the environment are recognised early.

In order to assess the total radiation dose received by a member of the public and for comparison with dose limits, samples are taken from the environment and the food chain. In this context the term sampling includes the collection of samples from the environment for laboratory analysis, and also selective direct measurements of dose rate in the environment to assess external exposure pathways. Most sampling and direct monitoring is conducted in the Sellafield immediate vicinity; in addition the Ravenglass estuary some 10 km south of the Sellafield site is closely monitored in order to determine the amount of sea-to-land transfer of radionuclides in this area.

9.1.2. Responsibilities

The operator carries out a part of the EMP. One of its objectives is to demonstrate that the allowed discharges have a minimal effect on the most exposed members of the critical group and that the dose to the public remains below the dose limit of 1 mSv per year.

In parallel to the operator programme the competent authorities run complementary EMPs, partly with the aim to verify the operator’s results. As approved by the Department of the Environment, Food and Rural Affairs (Defra), the responsibility for carrying out the EMP is split between the Environment Agency (EA) for the non-food pathways and the Food Standards Agency for the food chain pathways. Both agencies subcontract several laboratories to perform the analyses of their respective EMP.

9.2. BNFL monitoring programme

9.2.1. Introduction

The BNFL programme focuses on two main areas, terrestrial and marine monitoring, with the objective of quantifying potential doses to individuals, taking account of the data received from local population habit surveys. This is undertaken through direct measurement of dose rate and through analysis of environmental samples. The programme also defines levels of radioactivity in the environment for which immediate notification of the regulator is compulsory.

The media sampled in the BNFL programme are:

- Milk (from 6 farms within 4 km radius and from one farm in the Ravenglass area)
- Vegetables (potatoes, cabbage, peas, beetroot and cauliflower within 3 km radius)
- Fruit (elderberry, blackberry, strawberry, apple etc.)
- Meat (cattle, sheep, game, geese, deer, rabbit within 3 km radius and in the Ravenglass area)
- Drinking water (population centres within 15 km radius)
- Surface water (rivers Calder, Ehern and Lakes)
- Ground water on site
- Surface contamination (dose rate on 15 km of coastline)
- Seawater (15 km radius)

- Sand and mud
- Seaweed
- Fish, Crustacea and Molluscs (locally caught)

Locations for the BNFL terrestrial and marine sampling are presented in Appendices 8 and 9.

9.2.2. Sample analysis

Geoffrey-Schofield Laboratory (GSL) at Westlakes is in charge of sample analysis and data management. GSL is owned by BNFL and manages personnel, aerial and liquid effluents and environmental monitoring. It was opened in 1991 and was previously situated at the Sellafield site. It employs some 55 persons.

9.2.3. Quality assurance arrangements

GSL is accredited by the UK Accreditation Service (UKAS) to ISO 17025 and had its last audit in November 2003. The laboratory takes part in national and international intercomparison exercises.

9.2.4. Reporting of results

Results of the measurements and analyses undertaken are reported to the EA on summary record forms. Record forms are dispatched quarterly before the end of the subsequent quarter. The format of the summary record forms cannot be changed without EA agreement. Records are retained as agreed with the EA.

9.3. Environment Agency monitoring programme

9.3.1. Introduction

The EA carries out the following nation-wide routine monitoring programmes in the UK:

- Monitoring of the environment, primarily in the vicinity of nuclear sites
- Monitoring of effluent samples provided by nuclear site operators
- Waste quality checking of solid low level radioactive waste disposals [6]
- Air and rainwater in the United Kingdom on behalf of Defra to fulfil Euratom Treaty Article 35 & 36 requirements
- Drinking water sources in England and Wales on behalf of Defra to fulfil Euratom Treaty Article 35 & 36 requirements

The programmes are tailored to the individual site authorisations with regard to what types of samples are collected and nuclides analysed. The programmes are competitively tendered and carried out by individual contractors. An outline flowchart of the programme is presented in Appendix 10.

9.3.2. Quality assurance arrangements

To ensure the standard of monitoring data the EA requires the contractors to be accredited by the UK Accreditation Service (UKAS) to ISO 17025. The contractors all hold certified procedures that are available for inspection at their laboratories. Additionally the contractors are required to take part in national and/or international inter-comparison exercises.

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6 This programme is not within the scope of Article 35 of the Euratom Treaty.

9.3.3. *Effluent monitoring programme*

The EA requires operators of nuclear licensed sites to provide samples of their liquid and some gaseous effluents for independent radiochemical analysis. The results provide checks on site operators' returns and insights into their quality assurance procedures and analytical techniques.

The sampling consists of either single spot samples or monthly or quarterly bulked samples as appropriate. Currently the National Radiological Protection Board (NRPB) undertakes the analyses at its laboratories in Glasgow, Scotland.

9.3.4. *Environmental monitoring programme*

The EA undertakes a programme of monitoring radioactivity in the environment, where the radioactivity could lead to exposure of the public from non-food pathways, such as might arise from the occupation of beaches, river banks or other areas. The programme consists of surveys of gamma dose rates and contact beta/gamma dose rates at specified locations and laboratory analysis of radionuclide concentrations in environmental samples taken from specified locations in the vicinity of nuclear sites and other industrial premises.

The main environmental sample types analysed are as follows:

- Sediment
- Seaweed
- Seawater
- Grass/Herbage
- Soil
- Gullypot sediment
- Natural water
- Drinking water

The selection of sampling and measurement points is based on a combination of factors, including measured dose rates and the occupancy of the areas. Local habit surveys are also considered when defining the monitoring programme.

Samples are normally taken quarterly and analysed by gamma spectrometry and in some cases, chemical extraction and separation followed by beta counting or alpha spectrometry.

Measurements of gamma dose rates above beach and river bank areas are made by measuring the absorbed dose rate in air (µGy/h) one metre above ground. Contact beta/gamma monitoring of debris at the most recent strand line on the beach or riverbank is also carried out.

9.3.5. *Air and rainwater*

Routine measurements of radioactivity in air and rainwater have been carried out for many years in the UK. The results provide information on the activity concentrations of radionuclides in air and the levels of radioactivity deposited in rainwater

Currently NNC Ltd. undertakes this analysis. Most methods used are accredited by UKAS. The seven sampling locations in the UK are Chilton (Oxfordshire), Aberporth (Dyfed), Conlig (Co Down, NI), Dishforth (Yorkshire), Eskdalemuir (Dumfrieshire), Lerwick (Shetland) and Orfordness (Suffolk). Airborne particulate material is sampled continuously at a height of about one metre above ground level. The closest stations to Sellafield are Eskdalemuir and Dishforth on mainland Britain and Conlig in Northern Ireland.

All air and rainwater samples are analysed quarterly by gamma-ray spectrometry. Monthly analysis is carried out on air and rain samples from Chilton and rain samples from Aberporth. Where appropriate, additional samples are also analysed for tritium and/or plutonium and americium.

9.3.6. Drinking water sources

Regular monitoring of radioactivity in water sources (rivers, reservoirs and boreholes) used for the supply of drinking water has also been carried out for many years in the UK. Until the end of 2003 this was undertaken by Harwell Scientifics Ltd using methods that are mostly accredited by UKAS. From 2004 onwards (following competitive tendering) the analyses have been undertaken by the Laboratory of the Government Chemist (LGC) using methods that are UKAS accredited. The results are also provided to Defra for submission to the European Commission under Article 36 of the Euratom Treaty.

Samples of water are taken from 31 sources on a near-daily basis and bulked over three-month periods to provide "quarterly bulks" for analysis. The samples are analysed for total alpha and total beta activities and a range of specific radionuclides.

9.3.7. Transmission of monitoring data and records

The contractors who undertake EA monitoring programmes have quality management procedures in place to provide an audit trail of results through to transmission to the EA. Some of these procedures form part of the laboratories' UKAS accreditation.

The EA holds an environmental radiological monitoring database that provides the repository for the monitoring data. Developments are underway to allow the results of the effluent monitoring programme to be uploaded to a similar effluent radiological monitoring database.

9.3.8. Notification of unusually high results

There are various stages at which unusually high results could be identified and highlighted to the Environment Agency:

- Directly following sampling in the field, as samples from areas of previously known high activity are monitored for dose rate in the field.
- Following receipt of the sample at the contractor's laboratory, where dose rate readings are taken on all samples.
- Directly following analysis where expert judgement is used to determine whether the activity is significantly above normal environmental levels.
- By utilising facilities in the environmental radiological monitoring database to look at action levels and trends.

Where results are considered "highly significant" the contract laboratory notifies the EA immediately. This procedure is also followed for beach strandline contact beta/gamma monitoring should a "hot particle" be found.

The action level facility of the database is also used to identify results that may not be "highly significant" but nevertheless are regarded as "interesting" or "noteworthy".

9.4. Food Standards Agency monitoring programme

9.4.1. Introduction

Nuclear sites are the prime focus of the Food Standards Agency monitoring programme with monitoring carried out close to each of the sites. Most food chain sampling and direct monitoring [7] is

[7] Direct monitoring task is currently being gradually transferred to the EA.

conducted in the site's immediate vicinity. However, radionuclides (such as Tc-99) discharged in liquid effluents from BNFL Sellafield can be detected in the marine environment in many parts of north-European waters; hence the programme for this site extends beyond national boundaries.

The description of the work undertaken can be conveniently divided into two main categories: aquatic and terrestrial. The aquatic programme deals with contamination in or near the sea, rivers and lakes and acts as a check on disposals of liquid wastes. In this programme, the pathways that are the most relevant are the ingestion of seafood and freshwater fish, drinking water and external exposure from contaminated materials.

The terrestrial programme deals with contamination on land, which is dominated by disposals to the atmosphere. The relevant pathways are the ingestion of terrestrial foods, inhalation of airborne activity and external exposure from material in the air and deposited on land.

Work is also undertaken on general diet surveys, which provide information on radionuclides in the food supply to the whole population. Flowcharts of the monitoring programmes are provided in Appendix 13.

9.4.2. Methods of measurement

For the above programmes there are two basic types of measurement made:

- Samples are collected from the environment and analysed for their radionuclide content in a laboratory.
- Dose rates are measured directly in the environment.

The analyses carried out on samples vary according to the nature of the radionuclide under investigation. The types of analysis can be broadly categorised in two groups:

- Gamma-ray spectrometry
- Radiochemical methods

The latter are only used when there is clear expectation that information is needed on specific radionuclides that are not detectable using gamma spectrometry.

Two laboratories analyse samples. Their main responsibilities are as follows:

- CEFAS (Centre for Environment, Fisheries and Aquaculture Science)
  i. Lowestoft Laboratory - Analysis of aquatic samples.
  ii. Whitehaven Laboratory - Collection and some limited preparation of samples prior to their dispatch to the main laboratory at Lowestoft.
- VLA (Veterinary Laboratory Agency) - Gamma spectrometry and radiochemistry of terrestrial samples.

Each laboratory operates a quality control procedure to UKAS or other accreditation standards required by the Food Standards Agency. Intercomparison exercises are also undertaken with other laboratories in the UK and in Europe.

The analysis of foodstuffs is carried out on that part of the sampled material that is normally eaten. Foodstuff samples are prepared in such a way so as to minimise losses of activity during the analytical stage (losses due to normal food cooking are in most cases taken into account).

Measurements of gamma dose in air over intertidal areas are normally made at 1 m above the ground. External beta doses are measured on contact with the source, for example, fishing nets. The instruments are calibrated against recognised reference standards.

9.4.3. Notification of unusually high results

There are procedures for the VLA and CEFAS to notify the Food Standards Agency as soon as possible on unusually high analytical results. The Food Standards Agency will investigate at once, usually requesting a re-run of the analysis and notifying the EA and/or the nuclear site.

The Food Standards Agency also uses “trigger levels” for each radionuclide in each foodstuff based on 25% of the Generalised Derived Limit (GDL). If this trigger level is exceeded in any foodstuff, the Food Standards Agency will investigate the cause as a matter of urgency.

9.5. EA and Food Standards Agency monitoring around the Sellafield area

9.5.1. Environment Agency monitoring

The EA monitoring specific to the Sellafield area is within two of the main monitoring programmes: the environmental and effluent monitoring programmes.

The effluent monitoring programme at Sellafield consists of analysing quarterly bulk samples (both stabilised and non-stabilised) of aqueous liquid effluent from SIXEP, SETP, THORP (feed pond and dissolver off gas), EARP, Seaburn sewer and Magnox separation area. Additionally spot compliance samples are taken from these plants except the latter two, and the collection of these samples is witnessed by the Agency’s contractor, NRPB. Bubbler liquor samples are also analysed from stack bubblers in the Magnox and THORP dissolver off gas plants and filters are analysed from THORP. These samples are designed to monitor the releases of radioactive waste to atmosphere. Aqueous liquid effluents are also sampled from the Drigg pipeline.

The environmental monitoring consists of sampling of natural waters, reservoir supplies, sediments, seawater, seaweed and drainage gully pot sediments. Measurements of gamma dose rates and beta/gamma contamination levels are also made at several locations. Currently the EA environmental monitoring in Sellafield is carried out by Harwell Scientifics Limited in Oxfordshire. Appendices 11 and 12 present the monitoring and sampling locations of the EA programme in the Sellafield area.

9.5.2. Food Standards Agency monitoring.

The Food Standards Agency monitoring specific to the Sellafield area is within two of the main monitoring programmes: the aquatic and terrestrial programmes.

The main components of the aquatic programme are sampling and laboratory analysis of a wide range of seafood and indicator materials and selected direct measurements of external dose rates in areas of known or suspected contamination, and where public occupation occurs or is likely to occur. In both cases, the frequency of measurement depends on the level of environmental impact from the source under scrutiny, with the intervals between measurements varying between 1 week and 1 year. The types of material sampled and the locations from which samples are taken are chosen to be representative of existing exposure pathways.

The main focus of the terrestrial programme is the sampling and analysis of foodstuffs that may be affected by discharges to the atmosphere. In some cases where food availability is limited, environmental indicator materials such as grass are monitored. The types of foodstuff sampled are chosen on a site-by-site basis to reflect local availability, and to provide information on: (i) the main components of diet; milk, meat and cereals, and (ii) products most likely to be contaminated by discharge deposition, such as leafy green vegetables or soft fruit. Minor foods such as mushrooms and honey, which under certain circumstances are known to accumulate radioactivity, may also be sampled when available. Also minor pathways of radioactivity through the foodchain are monitored or estimated, for example the sea to land transfer of radioactivity in the Ravenglass area. The sampling locations for the Food Standards Agency programme (except farms) are shown in Appendix 15.

The Food Standards Agency also has an ad-hoc reactive monitoring programme that is available to undertake sampling and monitoring in support of specific investigations, for example if a site reported any unusually high discharges or incidents. Results are reported in the relevant annual RIFE report as a result of specially commissioned research projects, for example Tc-99 in farmed salmon, or radioactivity in uncommon seafood.

9.5.3. Reporting of EA and Food Standards Agency results

The EA and the Food Standards Agency results from the monitoring programmes are published in annual reports. Prior to 2003 these were separate report series, but in 2003 a joint report, Radioactivity in Food and the Environment (RIFE-8), was produced by Environment Agency, the Food Standards Agency, the Scottish Environment Protection Agency (SEPA) and the Environment and Heritage Service for Northern Ireland (EHS) for the results of work undertaken in 2002. The RIFE reports are made available via the EA's, FSA's, SEPA's and EHS's websites at http://www.environment-agency.gov.uk, http://ww.food.gov.uk, www.sepa.org.uk and www.ehsni.gov.uk. Joint reporting will be continued in future years, and this will be extended to incorporate information from the Nuclear Installations Inspectorate on direct radiation dose rate results. The results of the Food Standards Agency programme are also available on the Food Standards Agency web site http://www.food.gov.uk and steps are being taken to make the Environment Agency results available via the Internet too.

The results from both the air and rainwater and public drinking water sources monitoring are also supplied to Defra for forward transmission to the European Commission under Article 36 of the Euratom Treaty.

10. VERIFICATION ACTIVITIES - ENVIRONMENTAL MONITORING PROGRAMMES

10.1. BNFL monitoring programme

10.1.1. Onsite dose rate and aerosol sampling

The team verified that a step filter band aerosol measuring device and a GM dose rate measuring device located in a container at the site was operational and connected to the site emergency control room. The verification team noted that the BNFL Environment monitoring staff does not manage these devices and the data produced by them is not part of the site environmental monitoring data.

The verification activities performed do not give rise to a specific recommendation. It is however suggested to explore the possibility to include information from that system in the site impact evaluation tasks.

10.1.2. Site perimeter dose monitoring

The team verified that one of the TLD monitoring stations located on the site perimeter (Westring road, code SF02) was in place. There are altogether 30 such stations on the site perimeter.

The verification activities performed do not give rise to a specific recommendation.

10.1.3. High volume air sampling

There are five high volume air sampling systems on site and ten in the surrounding district of Sellafield. The team verified the operation of the one on site close to the B167 north gate and existence of the one located close to the boat yard at Seascale village.

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 monthly, more often if needed. All the equipment and procedures involved were found to be well-documented and operated according to quality assured standards.

The verification activities performed do not give rise to a specific recommendation.

10.1.4. Grass and soil sampling

The team verified the existence of grass sampling sites close to the B167 north gate and close to the pipeline at North Ring Road. These sites are 4×4 meter fenced areas located next to the high volume air sampling systems. Grass is cut annually in order to get a sample of about 2-3 kg of grass. There are altogether five grass sampling areas on site. Cutting is performed at the same time during the growing season. Also an annual soil sample (10 cm depth) is taken from the same locations.

The verification activities performed do not give rise to a specific recommendation.

10.1.5. Rainwater sampling

The team visited the rainwater sampling device close to the B167 north gate. Rainwater is sampled on site on five locations using rainwater collection systems, which have a collection area of 314 cm^2 each. Collection bottles are checked daily and a wash-in is performed monthly using 100 ml of distilled water. The precipitation sampler is cleaned at every sample changing, the rinsing water being part of the sample.

The verification activities performed do not give rise to a specific recommendation. The verification team supports BNFL's intention to replace the translucent sample bottles with dark ones to better control algae growth.

10.1.6. Contaminated land low flow sampling

There is an extensive sampling survey programme on the Sellafield site to monitor the ground water activity due to the contaminated land underneath some of the older buildings (particularly under the older 'Separation Area' of the site). The verification team visited various groundwater sampling sites (part of the Sellafield contaminated land study) and observed groundwater sample collection using the 'old' manual method.

The team visited borehole 6228 on well P2, which has a depth of about 17 meters. This borehole is sampled monthly. Samples are analysed for Tritium and Tc-99 contamination. Sampling involves measurement of pH, conductivity, temperature and oxygen content on site in order to guarantee a representative groundwater sample. A sampling demonstration of the new micropurge system was set up by the contractor NSTS, which is in charge of the contaminated land survey. The demonstration failed due to equipment failure.

The verification activities performed do not give rise to a specific recommendation.

10.1.7. Onsite groundwater sampling

The team visited borehole #2 close to the north gate. The depth of this borehole is not known exactly, but a typical borehole on site has about 20 m depth, maximum borehole depths are around 80 meters. There are altogether about 180 monitored boreholes within the site. From borehole #2 a one litre sample is taken monthly. The borehole is equipped with a micropurge system in order to maintain stable sample chemistry.

The verification activities performed do not give rise to a specific recommendation.

10.1.8. Offsite doserate monitoring

The verification team observed dose rate measurements as they are done twice annually near the Calder River railway bridge with the aim to check if there is any gradual increase and to establish a baseline for possible measurements after an incident or accident.

The verification activities performed do not give rise to a specific recommendation.

10.1.9. Offsite river and surface water sampling

The verification team witnessed the taking of a grab river water sample at Calder river upstream of the Sellafield site. No stabilisation is applied during sampling. On the sample bottle the location is marked beforehand, whereas it was said that the date 'will be added later'. Sampling time seemed not to be registered at all. River water flow at the time of sampling was not registered either. No documentation of the sampling is done on paper at the time of sampling.

The verification team recommends the marking of sampling date and time at the time of sampling on site. Sample description, name of sampler, remarks (e.g. flooding) and indication of the river flow rate should be noted on site.

10.1.10. Offsite milk and foodstuffs sampling

The verification team visited farm A6 (Seascale Hall near Calder Gate), which is one of the farms where milk samples are taken. The farmer takes a sample monthly on the first milking of cows. The farm holds altogether 220 cows of which 180-190 are milked. At the time of the visit the cows were stabled and fed on grass and cereals. Part of the silage feed may come from other parts of the country.

At the end of the year one cow or two sheep (alternating) are bought from farm A6 and are slaughtered. In addition, eggs (chicken and duck), chicken, duck and geese come from farm A6 for radionuclide analysis. Vegetable samples come from a neighbouring farm. Blackberry and elderberry from nearby are harvested in September.

The verification activities performed do not give rise to a specific recommendation. The team however notes that there might be a need to change the monitoring programme after the CEFAS/Food Standards Agency study on local foodstuffs consumption habits is finished (this is the Food Standards Agency standard practice).

10.1.11. Marine sampling and dose rate measurements

The verification team witnessed measurements and sampling of various sea organisms by BNFL staff during low tide at the Ravenglass estuary. The team witnessed dose rate measurements, hot particle search along flood line and sediment sampling. For sediments, the sample container with information stickers is prepared in advance, the sampling date being filled-in on-site. Sampling time is not registered. The tool for sampling sediment is cleaned after each sample. The collection points for ebb-tide marine samples (bladder wreck, winkles, cockles, mussels and marsh samphire) were visited and sampling methods demonstrated.

The verification activities performed do not give rise to a specific recommendation. The verification team suggests that the time of sampling be recorded to allow for better following of any multiple samplings.

10.1.12. Meteorological measurement systems

The meteorological station off-site could be visited by the verification team only outside the fence, since no key for access was available. It is owned and operated by Westlakes laboratory and contains a 50 m standard meteorological mast. Wind speed, temperature, etc. are measured; the data are used for atmospheric dispersion modelling. Basic data go to BNFL, but are not available on-line. The site is not included in the national meteorological system. The nearest official meteorological site is at Eskmeals (MOD range).

The verification activities performed do not give rise to a specific recommendation.

10.1.13. Data collection of aerial and liquid discharges

The EAGLE database (Environment Analysis of Gaseous and Liquid Effluents) was demonstrated to the verification team. This database is used to collect the information from the BNFL monitoring programmes. The database contains information on liquid batch discharges, continuous liquid discharges and aerial discharges. It provides information to the EA and to the BNFL personnel. The system is based on the Oracle database with a Microsoft Access front-end. Data (laboratory serial number, plant number, discharge times, volume, dilution factor etc.) is sent electronically, but typed manually into the database. The database has trigger values (based on previous plant performance) for each plant in order to spot possible problems in advance. If a trigger value is breached on two consecutive months, the EA has to be notified and an internal investigation started. An Environment Agency witnessing procedure is in place for additional confidence. There is a daily back up of the EAGLE server; in addition records are kept on paper.

The verification activities performed do not give rise to a specific recommendation.

10.1.14. Estimation of gaseous discharges from Sellafield

The gaseous discharges from the many relatively minor sources at the Sellafield site are estimated according to the so called “Approved places methodology”, which implies that the discharges are not estimated based on individual facilities stack monitor readings, but based on the results of the five high volume air samplers located on the site perimeter. A dispersion model is used to transfer air sampler results into estimation of total aerial discharges from the Sellafield site, which is then fed into the EAGLE database. This system is in place since the site has several possible discharge points, which are not monitored directly, and some points, which are monitored but the data is not used for accounting. Especially some of the old nuclear facilities waiting for decommissioning cannot practically be monitored for all gaseous discharges. It should be mentioned, that most of the operating facilities have stack monitoring systems, so aerial discharges of these facilities are monitored directly and this data supports the Approved places methodology. The verification team received a description of the methodology and was able to discuss it in detail with the BNFL personnel. The team acknowledges the fact that this methodology has been approved by the EA and the personnel involved are aware of its uncertainties and limitations.

The Sellafield site, in particular its THORP plant, is one of two substantial sources of Kr-85 discharge to atmosphere within the European Union. While discharges of Kr-85 are monitored in the release duct of the THORP main stack via total beta measurement, neither the operator nor the regulator provide for the measurement of Kr-85 in the environment of the site, off-site, or in the rest of the UK.

The verification team points out that the “Approved places methodology” involves large uncertainties and should therefore be applied with appropriate safety margins. The verification team notes that up to 30% of the aerial discharges from the Sellafield site are from so called ‘approved places’ and the accountancy estimates of these discharges are provided for by a combination of data from on-site high volume air samplers and the application of environmental modelling. While this practice is carried out with the approval of the Environment Agency, the verification team recommends that the Environment Agency review the efficacy of this practice.

Additionally, it is recommended that the EA review whether sampling of Kr-85 in the environment should be made an integral part of environmental monitoring policy.

10.1.15. Geoffrey Schofield Laboratory

The verification team visited the Geoffrey Schofield Laboratory (GSL) at the Westlakes Science and Technology Park. The team had the opportunity to follow the line from sample arrival over sample preparation to sample measurement and reporting.

The verification team confirmed that the discharge analysis in the GSL laboratory are recorded in a centralised computed database SLIMS (Sellafield Laboratory Information Management System). This system will in the near future be updated with an improved system (SLIMS II).

The verification team had a thorough look at the measurement systems in use. Liquid Scintillation Counting is used for measurement of Sr-90, total-ß (Cherenkov), C-14, S-35, H-3 and I-129. For gamma spectrometric analysis several HPGe, Ge(Li) and low energy photon spectrometers are used (Ortec, Canberra). Two gamma spectroscopy systems are equipped with automatic sample changers. For spectrum analysis the µVAX version of the GENIE software is used, but at the time of verification a shift to Canberra Genie PC was under preparation. The equipment operator checks each spectrum analysis printout and approves the significant peaks used in the analysis. A visual inspection of the actual spectra is performed if deemed necessary.

For gamma spectrometry efficiency calibration a mixed radionuclide standard (MRNS QCY.48 / 10 nuclides in aqueous solution) is used. With this standard an efficiency curve and an uncertainty curve (no summing corrections) is generated. In addition, individual isotope standards (Cs-137, Ru-106 and Co-60) are available for calibration. A simple sample density correction is applied. A Monte Carlo simulation approach for density correction is not foreseen. Six standard geometries have been introduced for liquids (5 ml up to 3 l). These geometries are also used for solids. In addition, there are efficiency calibrations for CTBTO-polypropylene filter paper and HiVol glass fiber filter paper (Marinelli type geometry). For these calibrations the standard is a paper with activity applied in small spots. Efficiency re-calibration is performed every two years for each spectrometer.

At the moment there is no procedure for archiving gamma spectra because of a physical limitation (the spectra are all stored on tape). For the future system a procedure will be set-up, time of installation has not yet been decided.

The verification team supports the shift from the µVAX/VMS based system and suggests a re-thinking of the philosophy that lies behind using a library driven peak force-fit if this would not lead to unreasonable delays on system introduction.

The verification team also supports the designing of a spectrum archiving procedure already in the planning phase for the new system.

For alpha spectrometry some 84 Passivated Implanted Planar Silicon (PIPS) detectors are in use with a Canberra alpha-analyst system. Sample-detector distance has been optimised regarding efficiency and resolution. The calculation of activities is semi-automated via a spreadsheet application. It is foreseen that the future SLIMS II will bring an improvement by eliminating manual input altogether.

For the analysis of metals in seawater and e.g. Tc-99 and Np in boreholes ICP mass spectrometry is used. At the moment no reaction cell is available to separate U-238 and Pu-238 which leads to some limitations.

Regarding sample management each environmental sample is accompanied by a ‘change of custody form’ for the hand-over containing all relevant information and signatures. From this form relevant data are taken and are manually typed into the laboratory system. This system gives an LSN (laboratory serial number) which is an internal laboratory number on the computer on-site; labels are printed out and attached to the sample. A hand written note is made in the sample register book. A copy of the 'change of custody form' goes back to the customer. A description of all analytical steps/procedures and the priority of the sample are supplied. The analytical schedule is available via SLIMS and on paper.

A new laboratory management system (SLIMS II) will be available in 18 months; at the moment the system requirements are being collected and analysed.

There are procedures in place for correcting possible errors ('amended results'). The customer would be contacted immediately when an error is found. The 'old' erroneous data will stay in the system for transparency reasons.

The verification team noted that the Lower Limit of Detection (LLD) for an analysis frequently is determined by an algorithm associated to the EAGLE database, based on the measurement result (which is derived from a forced fit peak area calculation in gamma spectrometry and has a large uncertainty).

The verification team suggests to explore the possibility to use internationally applied algorithms for the calculation of LLDs, decision thresholds etc. and for this purpose would like to refer to the International Standard ISO 11929-7:2005.

Procedures, technical manuals are available within reach and are very detailed. Alpha analysis procedures include formulae for manual calculations if needed. For equipment originating from Canberra there is a service contract.

There is a procedure in place concerning disposal of samples (how long to keep; when to be sent back to customer; for borehole water there is authorisation for draining in sink).

For verification of data handling a milk sample (milk A6, Seascale Hall, July 2002) was chosen by the verification team. A check of SLIMS showed the laboratory serial number (766906) and the gamma spectrometry analysis results. Since the original gamma spectrometry printout was not available in the laboratory (since October 2003 the paper copies are stored in an archive at Lillyhall, some 10 miles away) a spectrum re-analysis was performed. The spectrum analysis printout for the 24 hr, 3 l Marinelli measurement shows a weak peak for I-131 with a large uncertainty (145 % 1 sigma). The value was the same as reported in SLIMS. Since GSL has no access to the EAGLE database verification of the stored value for I-131 (the reported value or a derived LLD) was not possible.

The verification team recommends giving the analysis laboratory access to the EAGLE database.

For K-40 the value on the SLIMS printout was different to the one on the gamma spectrometry printout because another value was subtracted for K-40 background. The current system gives no indication which background file is used for analysis whereas the new system is foreseen to give such an indication.

The verification team supports the introduction of such a system that gives all relevant information regarding the analysis parameters including the background file used.

According to the gamma spectrometry analysis printout the spectrum verified was acquired on 1-AUG-2002 09:52:53.88, i.e. only some 30 seconds after 'sample time' (1-AUG-2002 09:52:26.92) which for a milk sample given the sampling procedure seems rather unrealistic.

The verification team recommends using the real sampling and spectrum acquisition dates.

In addition, the verification team examined the analysis report for a random aerosol sample (HiVol North Gate, Nov 2003). The team found the original still available at the GSL with all signatures and initials in order. Also checkmarks on the printout and the data in SLIMS were in good order.

Regarding the work of the laboratory (in particular gamma spectrometry) under adverse contamination situations the verification team noted that there is air conditioning (no pre-filtered air) and the building roof is directly above the gamma spectrometry room. According to the laboratory operator the construction of an underground laboratory was in discussion but dismissed on financial grounds.

10.1.16. Additional verification findings and remarks

During the course of the visit the verification team confirmed the existence and adequacy of the environmental monitoring provisions.

The verification team satisfactorily performed a series of spot-checks on historic samples in order to verify the traceability of environmental data.

The verification team noted the robustness of the internal quality assurance and control present at the GSL laboratory. Sample management, analytical procedures and record keeping showed the laboratory to be operated according to high standards. Data management is consistent and adequate archiving of results is in place. Maintenance and calibration procedures for the analytical measurement devices present in the laboratory are well organised.

The team also noted that the electronic storage of data is organised in such a way as to allow the visualisation of historical trends for individual nuclides present in the environment. The data interrogation capabilities that have been implemented provide added value to the statutory environmental monitoring programme.

10.2. Environment Agency monitoring programme

10.2.1. Sampling programme

Apart from the sampling demonstrations witnessed at the Ravenglass estuary the functionality of sampling programme of the EA could not be directly verified, since contractors do the sampling according to a predefined schedule. The verification team was able to confirm the existence of the programme documentation and verify the programme contents through documents and discussions with the EA staff present during the verification visit. At Ravenglass estuary EA contractor Harwell Scientifics' demonstrated sediment sampling and monitoring for both gamma dose rate and contact beta/gamma dose rates (hot particle search along flood line). The sampling equipment and the file including risk assessments and chain of custody forms were shown to the verification team along with documents presenting the predefined schedule.

The verification activities performed do not give rise to a specific recommendation.

10.3. Food Standards Agency monitoring programme

10.3.1. Sampling programme

Apart from the sampling demonstrations witnessed at the Ravenglass estuary the functionality of sampling programme of the Food Standards Agency could not be directly verified, since contractors do the sampling according to a predefined schedule. The verification team was able to confirm the existence of the programme documentation and verify the programme contents through documents and discussions with the Food Standards Agency staff present during the verification visit. At Ravenglass the collection points for ebb-tide marine samples (bladder wreck, winkles, cockles, mussels and marsh samphire) were visited and sampling methods demonstrated by the CEFAS representative (Food Safety Agency contractor). This represented the demarcation between the environmental and foodstuffs monitoring programmes, although seaweeds are also collected on behalf of the EA as they are a good environmental indicator.

The verification activities performed do not give rise to a specific recommendation.

11. CONCLUSION

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

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

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the site of Sellafield are adequate. The Commission could verify the operation and efficacy of these facilities.

(2) However, a number of recommendations are formulated, mainly in relation to general quality assurance and control. These recommendations aim at improving some aspects of the environmental surveillance in and around the Sellafield site. These recommendations do not detract from the general conclusion that the Sellafield site is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(3) The recommendations are detailed in the 'Main Findings' document that is addressed to the United Kingdom competent authority through the United Kingdom Permanent Representative to the European Union.

APPENDIX 1

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APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY

Monday 8 March

Morning	Opening meeting	
Afternoon	Team-1	THORP and SMP gaseous discharge monitoring/sampling provisions
	Team-2	Onsite dose rate monitoring High volume air sampling Grass and soil sampling

Tuesday 9 March

Morning	Team-1	THORP liquid discharge monitoring/sampling provisions
	Team-2	Onsite borehole sampling Onsite contaminated land sampling
Afternoon	Team-1	EARP liquid discharge monitoring/sampling provisions
	Team-2	Offsite dose rate monitoring Offsite river and surface water sampling Offsite milk sampling

Wednesday 10 March

Morning	Team-1	SETP liquid discharge monitoring/sampling provisions
	Team-2	Offsite sampling at Ravenglass beach Offsite marine sampling and surveys
Afternoon	Team-1	SIXEP gaseous and liquid discharge monitoring/sampling provisions
	Team-2	Demonstration of the reporting database EAGLE

Thursday 11 March

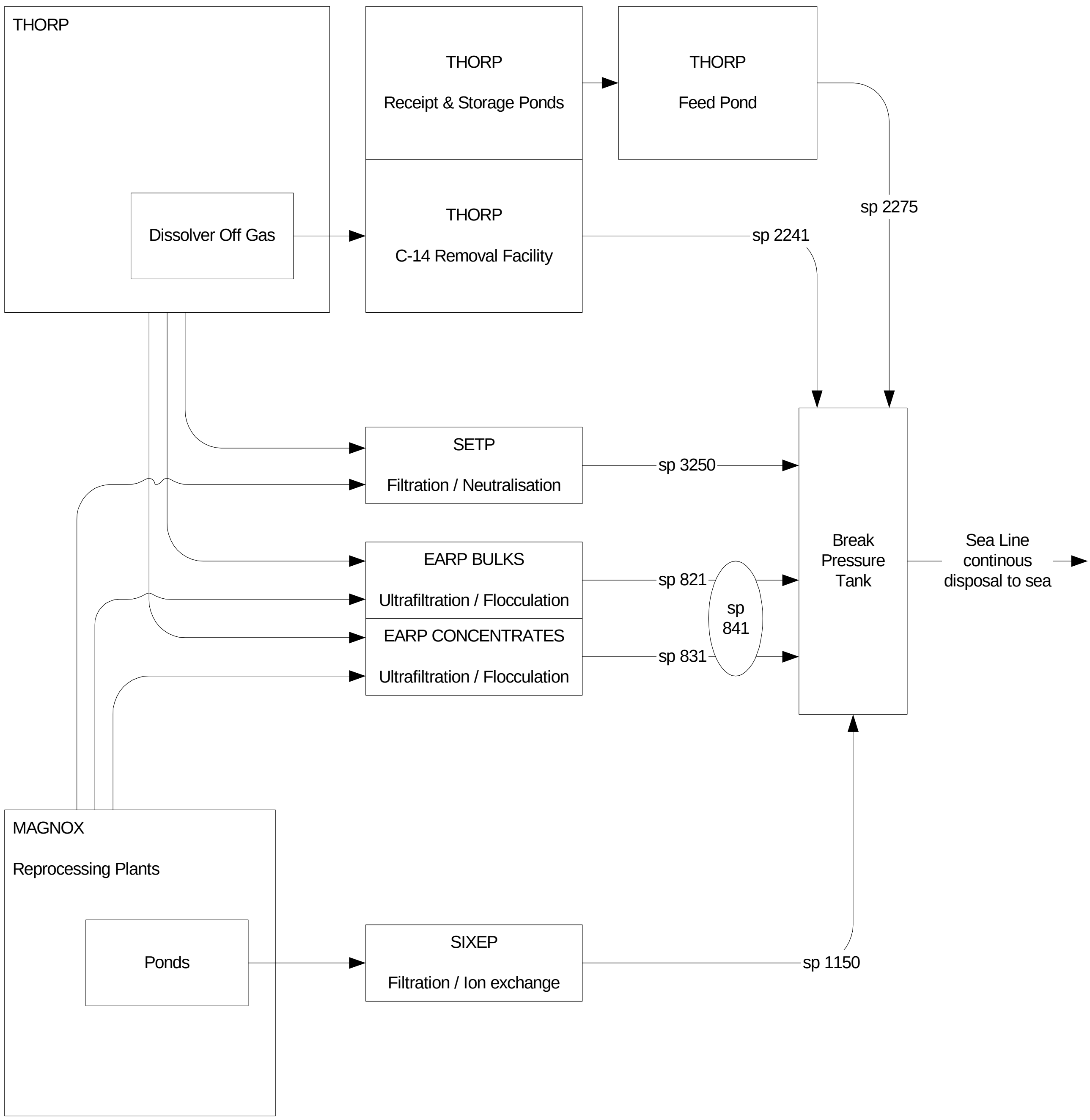
Morning	Team-1	Effluent samples laboratory
	Team-2	GSL environmental samples laboratory
Afternoon	Team-1	Effluent samples laboratory Demonstration of the reporting database EAGLE
	Team-2	GSL environmental samples laboratory

Friday 12 March

Morning	Closing meeting	

APPENDIX 3

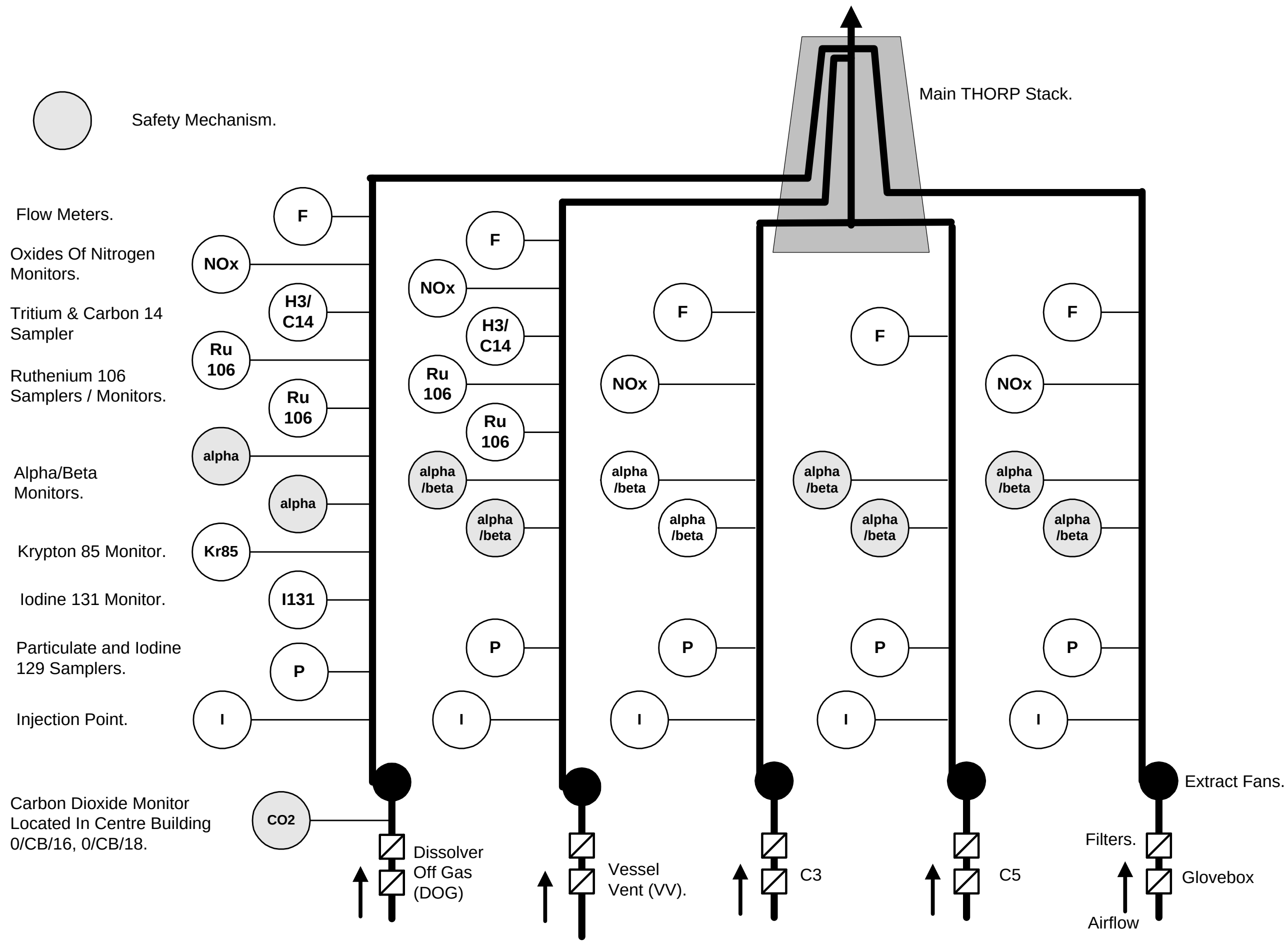
LIQUID DISCHARGE ROUTES – OVERVIEW



SP 2275 - THORP - continuous discharge to BPT, daily proportional sample
SP 2241 - THORP - batchwise discharge to BPT, one spot sample per batch (tank) before discharge
SP 821 - EARP - batchwise discharge to BPT, one proportional sample per batch (tank) before discharge
SP 831 - EARP - batchwise discharge to BPT, one spot sample per batch (tank) before discharge
SP 3250 - SETP - batchwise discharge to BPT, one proportional sample per batch (tank) before discharge
SP 1150 - SIXEP - continuous discharge to BPT, daily proportional sample

APPENDIX 4

THORP STACK DISCHARGE MONITORING AND SAMPLING - OVERVIEW



APPENDIX 5

THORP STACK DISCHARGE – SUMMARY OF ACCOUNTANCY SAMPLE POINTS

Sample Point Number	Function (Purpose of Sample Point)	Type of Equipment	Operational Parameters	Measurement Parameters	Maintenance Regime/Schedule
2101	DOG (Dissolver Off Gas) discharge accountancy particulate sampler. Analytes: Alpha, Beta, Sr90, Ru106, Cs137, PuAlpha, Pu241, Am241+CM242.	Bird and Tole in Line Filter Holder MK 2 - BTS309	Sample flowrate 37 l/min. Flow electronically totalised over sample period. Daily change, weekly bulk for analysis. HP&S daily count (initial decay). Motive force- bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across filter card annunciated at CCR (Central Control Room) via DCS (Distributed Control System).	Annual proof test. TEST/SERV/0237.
2102	DOG discharge accountancy Ru106 sampler (incorporates real time Ru106 monitor).	NaOH scrubber column with integral low resolution gamma spectrometer (on line monitor).	Sample flowrate 37/1 min. Flow electronically totalised over sample period. Liquor circulated at 180 l/min. Daily change, weekly bulk for analysis. Duty and standby sampler installed. Motive force-bottled backed instrument air (auto changeover) to ejector. Battery backed electrical supply to pump circulating NaOH solution.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low sample flow alarm. Caustic scrubber liquor low flow alarm. High and low caustic scrubber liquor level alarm. Caustic scrubber circulating pump fail alarm. Detector failure alarm. Power fail alarm. All alarms annunciated at CCR via DCS.	Annual proof test. Quarterly preventative maintenance regime. TEST/SERV/0153.
2103	DOG discharge accountancy I129 sampler. Also analysed for I131.	Maypack - Silver Zeolite.	Sample flowrate 10 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across Maypack annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0238.
2104/2105	DOG discharge accountancy H3 (2104) and C14 (2105) sampler.	H3 - 3 flasks containing demin water, 1000°C oxidising furnace between flask 1 and 2. C14 - 2 flasks containing NaOH solution.	Sample flowrate 1 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Duty and standby furnace (auto changeover). Motive force bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm. Low furnace temperature alarm. Power fail alarm. All alarms annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0246.
2106	Vessel vent discharge accountancy particulate sampler. Used for: Alpha, Beta, Sr90, Ru106, CS137, PuAlpha, Pu241, Am241+CM242.	Bird and Tole in Line Filter Holder MK 2 - BTS309	Sample flowrate 37 l/min. Flow electronically totalised over sample period. Daily change, weekly bulk for analysis. HP&S daily count (initial decay). Motive force- bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across filter card annunciated at CCR (Central Control Room) via DCS (Distributed Control System).	Annual proof test. TEST/SERV/0239.
2107	Vessel vent discharge accountancy Ru106 sampler (incorporates real time Ru106 monitor).	NaOH scrubber column with integral low resolution gamma spectrometer (on line monitor).	Sample flowrate 37/1 min. Flow electronically totalised over sample period. Liquor circulated at 180 l/min. Daily change, weekly bulk for analysis. Duty and standby sampler installed. Motive force-bottled backed instrument air (auto changeover) to ejector. Battery backed electrical supply to pump circulating NaOH solution.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low sample flow alarm. Caustic scrubber liquor low flow alarm. High and low caustic scrubber liquor level alarm. Caustic scrubber circulating pump fail alarm. Detector failure alarm. Power fail alarm. All alarms annunciated at CCR via DCS.	Annual proof test. Quarterly preventative maintenance regime. TEST/SERV/0152.

Cont'd

2108	Vessel vent discharge accountancy I129 sampler.	Maypack - Silver Zeolite.	Sample flowrate 10 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across Maypack annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0240.
2109	Glovebox extract discharge accountancy particulate sampler. Used for: Alpha, Beta, Sr90, Ru106, Cs137, PuAlpha, Pu241, Am241+CM242.	Bird and Tole In Line Filter Holder MK2 - BTS309.	Sample flowrate 37 l/min. Flow electronically totalised over sample period. Daily change, weekly bulk for analysis. HP&S daily count (initial decay). Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across filter card annunciated at CCR (Central Control Room) via DCS (Distributed Control System).	Annual proof test. TEST/SERV/0245.
2110	Glovebox extract discharge accountancy I129 sampler.	Maypack - Silver Zeolite.	Sample flowrate 10 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Motive force - bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across Maypack annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0244.
2111	C3 area extract discharge accountancy particulate sampler. Analytes Alpha, Beta, Sr90, Ru106, Cs137, PuAlpha, Pu241, Am241+Cm242.	Bird and Tole In Line Filter Holder MK2 - BTS309.	Sample flowrate 37/1 min. Flow electronically totalised over sample period. Daily change, weekly bulk for analysis. HP&S daily count (initial decay). Motive force - bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across filter card annunciated at CCR (Central Control Room) via DCS (Distributed Control System).	Annual proof test. TEST/SERV/0234. TEST/SERV/0235.
2112	C3 area extract discharge accountancy I129 sampler.	Maypack - Silver Zeolite.	Sample flowrate 10 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across Maypack annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0236.
2113	C5 cell/cave extract discharge accountancy particulate sampler. Analytes Alpha, Beta, Sr90, Ru106, Cs137, PuAlpha, Pu241, Am241+Cm242.	Bird and Tole In Line Filter Holder MK2 - BTS309.	Sample flowrate 37 l/min. Flow electronically totalised over sample period. Daily change, weekly bulk for analysis. HP&S daily count (initial decay). Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low differential pressure alarm across filter card annunciated at CCR (Central Control Room) via DCS (Distributed Control System).	Annual proof test. TEST/SERV/0241. TEST/SERV/0242.
2114	C5 cell/cave extract discharge accountancy I129 sampler.	Maypack - Silver Zeolite.	Sample flowrate 10 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Motive force- bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm and low and high differential pressure alarm across Maypack annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0243.
2119/2120	VV discharge accountancy H3 (2119) and C14 (2120) sampler.	H3 - 3 flasks containing demin water, 1000°C oxidising furnace between flask 1 and 2. C14- 3 flasks containing NaOH solution.	Sample flowrate 1 l/min. Flow electronically totalised over sample period. Weekly changed - sent for analysis. Single furnace. Motive force-bottled backed instrument air (auto changeover) to ejector.	Sample flowrate (rotameter) connected to electronic flowmeter for sample flow totalisation. Low flow alarm. Low furnace temperature alarm. Power fail alarm. All alarms annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0673

APPENDIX 6

THORP STACK DISCHARGE – SUMMARY OF STACK DISCHARGE MONITORS

Instrument Reference	Function (Purpose of Sample Point)	Type of Equipment	Operational Parameters	Measurement Parameters	Maintenance Regime/Schedule
FQJNA 0752A/B	C5 cell/cave discharge duct flow instrument.	TEKFLO flow grid.	Two transducers operate in parallel. Battery backed power supplies.	Measures differential pressure across flow grids - gives 4 - 20 mA signal to DCS to give m^3/hr and total m^3 of air discharged over 24 hour period. Discrepancy alarm between A and B instrument at CCR via DCS. High and low duct flow alarms. Hardwired low flow alarm.	Annual proof test. TEST/SERV/0215. TEST/SERV/0216.
RRJNA 0845	DOG on line Iodine 131 monitor.	Low resolution gamma spectrometry. (Lab Impex 9000 series). Silver Zeolite (Maypack) absorber.	Sample flow 20 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Analysis of Maypack if required.	Gamma spectrometry. 4 - 20 mA signal to DCS giving Bq/hr and total Bq discharged. Low sample flow alarm. Low differential pressure alarm across I131 absorber. Detector failure alarm. Power fail alarm. All alarms in CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Quarterly proof test. TEST/SERV/0151.
RRJNA 0813A/B	DOG on line Ruthenium 106 monitor. (Integral with accountancy sampler 2102).	Low resolution gamma spectrometry. (Lab Impex 9000 series). Detector located against accountancy sampler caustic scrubber reservoir.	Sample air flow 31 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Sample analysis as 2102.	Gamma spectrometry. 4 - 20mA signal to DCS giving Bq/hr and total Bq discharged. Low sample flow alarm. Caustic scrubber liquor low flow alarm. High and low caustic scrubber liquor level alarm. Caustic scrubber circulating pump fail alarm. Detector failure alarm. Power fail alarm. All alarms in CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0153.
RRJNA 0750A/B	Vessel vent on line Ruthenium 106 monitor. (Integral with accountancy sampler 2107).	Low resolution gamma spectrometry. (Lab Impex 9000 series). Detector located against accountancy sampler caustic scrubber reservoir.	Sample air flow 31 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Sample analysis as 2102.	Gamma spectrometry. 4 - 20mA signal to DCS giving Bq/hr and total Bq discharged. Low sample flow alarm. Caustic scrubber liquor low flow alarm. High and low caustic scrubber liquor level alarm. Caustic scrubber circulating pump fail alarm. Detector failure alarm. Power fail alarm. All alarms in CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0152.
FQJNA 0750A/B	DOG discharge duct flow instrument.	TEKFLO flow grid.	Two transducers operate in parallel. Battery backed power supplies.	Measures differential pressure across flow grids - gives 4 - 20 mA signal to DCS to give m^3/hr and total m^3 of air discharged over 24 hour period. Discrepancy alarm between A and B instrument at CCR via DCS. High and low duct flow alarms. Hardwired low flow alarm.	Annual proof test. TEST/SERV/0183. TEST/SERV/0212.

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FQJNA 0751A/B	Vessel vent discharge duct flow instrument.	TEKFLO flow grid.	Two transducers operate in parallel. Battery backed power supplies.	Measures differential pressure across flow grids - gives 4 - 20 mA signal to DCS to give m^3/hr and total m^3 of air discharged over 24 hour period. Discrepancy alarm between A and B instrument at CCR via DCS. High and low duct flow alarms. Hardwired low flow alarm.	Annual proof test. TEST/SERV/0213. TEST/SERV/0214.
FQJNA 0799A/B	Glovebox C5 discharge duct flow instrument.	TEKFLO flow grid.	Two transducers operate in parallel. Battery backed power supplies.	Measures differential pressure across flow grids - gives 4 - 20 mA signal to DCS to give m^3/hr and total m^3 of air discharged over 24 hour period. Discrepancy alarm between A and B instrument at CCR via DCS. High and low duct flow alarms. Hardwired low flow alarm.	Annual proof test. TEST/SERV/0249. TEST/SERV/0012.
FQJNA 0753A/B	C3 discharge duct flow instrument.	TEKFLO flow grid.	Two transducers operate in parallel. Battery backed power supplies.	Measures differential pressure across flow grids - gives 4 - 20 mA signal to DCS to give m^3/hr and total m^3 of air discharged over 24 hour period. Discrepancy alarm between A and B instrument at CCR via DCS. High and low duct flow alarms. Hardwired low flow alarm.	Annual proof test. TEST/SERV/0247. TEST/SERV/0248.
RJNA 0738A/B RJNA 0734A/B	Vessel vent discharge duct on line alpha/beta monitor.	Dual Lab Impex 900 series moving filter radiometric monitor	Sample flowrate 37 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Two monitors operate in parallel.	Sample flowrate via rotameter. Low sample flow alarm. Detector fail alarm. Paper jam alarm. Power loss alarm. All alarms at CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0146. TEST/SERV/0330.
RJNA 0739A/B	DOG discharge duct on line alpha monitor.	Dual Lab Impex 900 series moving filter radiometric monitor	Sample flowrate 37 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Two monitors operate in parallel.	Sample flowrate via rotameter. Low sample flow alarm. Detector fail alarm. Paper jam alarm. Power loss alarm. All alarms at CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0147. TEST/SERV/0331.
RJNA 0763A/B RJNA 0764A/B	Glovebox discharge duct on line alpha/beta monitor.	Dual Lab Impex 900 series moving filter radiometric monitor	Sample flowrate 37 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Two monitors operate in parallel.	Sample flowrate via rotameter. Low sample flow alarm. Detector fail alarm. Paper jam alarm. Power loss alarm. All alarms at CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0148. TEST/SERV/0332.
RJNA 0736A/B RJNA 0732A/B	C3 discharge duct on line alpha/beta monitor.	Dual Lab Impex 900 series moving filter radiometric monitor	Sample flowrate 37 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Two monitors operate in parallel.	Sample flowrate via rotameter. Low sample flow alarm. Detector fail alarm. Paper jam alarm. Power loss alarm. All alarms at CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0328. TEST/SERV/0002.

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RJNA 0733A/B RJNA 0737A/B	C5 discharge duct on line alpha/beta monitor.	Dual Lab Impex 900 series moving filter radiometric monitor	Sample flowrate 37 l/min. Battery backed power supplies. Bottle backed instrument air (auto changeover) to ejector. Two monitors operate in parallel.	Sample flowrate via rotameter. Low sample flow alarm. Detector fail alarm. Paper jam alarm. Power loss alarm. All alarms at CCR via DCS. Five levels of high activity alarm at CCR via DCS (one hardwired).	Quarterly preventative maintenance. Annual proof test. TEST/SERV/0145. TEST/SERV/0329.
RRJNA 0712	Krypton 85 on line monitor. Accountancy point.	Gamma spectrometer.	Sample flowrate 1 l/min. Temperature controlled sample. Two independent detectors and electronics are deployed within the instrument. System calculates the Kr85 discharge on a one minute cycle. Battery backed power supplies.	Instrument utilises duct flow measurement to calculate Kr85 discharged. Kr85 discharged displayed and recorded at the CCR via the DCS. Low sample flow alarm. Instrument fail alarm and instrument off line alarm (fatal and non-fatal alarms). All alarms annunciated at CCR via DCS.	Annual proof test. TEST/SERV/0197.

APPENDIX 7

SELLAFIELD DISCHARGE LIMITS (2003)

1. LIQUID DISCHARGES

1.1 Sea pipelines discharge limits

Radionuclide	Annual limit	Quarterly notification level
- Alpha emitting radionuclides	1 TBq	0.185 TBq
- Beta emitting radionuclides	400 TBq	74 TBq
- H-3	25000 TBq	8000 TBq
- C-14	20.8 TBq	5 TBq
- Co-60	13 TBq	3.3 TBq
- Sr-90	48 TBq	12 TBq
- Zr-95 + Nb-95	9 TBq	2.3 TBq
- Tc-99	90 TBq	50 TBq
- Ru-106	63 TBq	16 TBq
- I-129	1.6 TBq	0.5 TBq
- Cs-134	6.6 TBq	1.6 TBq
- Cs-137	75 TBq	19 TBq
- Cm-144	8 TBq	2 TBq
- Pu-238 + Pu-239 + Pu-240	0.7 TBq	0.19 TBq
- Pu-241	27 TBq	7 TBq
- Am-241	0.3 TBq	0.075 TBq
Uranium	2040 kg	

The annual limit is calculated on a rolling month basis.

1.2 Factory sewer discharge limits

Radionuclide	Annual limit	Quarterly notification level
- Alpha emitting radionuclides	3.3 GBq	0.8 GBq
- Beta emitting radionuclides	13.5 GBq	3.4 GBq
- H-3	132 GBq	33 GBq

1.3 Calendar year THORP related limits

Radionuclide	Annual limit	THORP Uranium throughput
- H-3	8400 TBq	< 100 tonnes
- I-129	0.8 TBq	
- H-3	18000 TBq	between 100 and 400 tonnes
- I-129	1.3 TBq	
- H-3	25000 TBq	> 400 tonnes (but < 800 tonnes)
- I-129	1.6 TBq	

2. GASEOUS DISCHARGES

Note: the Calder Hall nuclear power station is not considered here. It is however also subject to regulatory restrictions.

2.1 High discharge points (stacks with an effective height > 70 metres).

Radionuclide	Annual limit (GBq)	Quarterly notification level (GBq)
- Alpha emitting radionuclides	0.7	0.18
- Beta emitting radionuclides	5.2	1.3
- H-3	1.4 E+06	3.5 E+05
- C-14	5 E+03	1.3 E+03
- Kr-85	1.2 E+08	3 E+07
- Sr-90	0.1	0.025
- Ru-106	1.5	0.38
- I-129	32	8
- I-131	45	11
- Cs-137	0.23	0.06
- Pu-238 + Pu-239 + Pu-240	0.66	0.17
- Pu-241	4	1
- Am-241 + Cm-242	0.2	0.05

2.2 Intermediate discharge points (stacks with an effective height between 30 and 70 metres).

Radionuclide	Annual limit (GBq)	Quarterly notification level (GBq)
- Alpha emitting radionuclides	0.2	0.05
- Beta emitting radionuclides	17	4.3
- C-14	1.5 E+03	3.8 E+02
- Sr-90	1	0.25
- Ru-106	20	5
- I-129	4	1
- I-131	10	2.5
- Cs-137	5.1	1.3
- Pu-238 + Pu-239 + Pu-240	0.025	0.006
- Pu-241	0.2	0.05
- Am-241 + Cm-242	0.09	0.023

2.3 Low discharge points (stacks with an effective height < 30 metres).

Radionuclide	Annual limit (GBq)	Quarterly notification level (GBq)
- Alpha emitting radionuclides	0.06	0.015
- Beta emitting radionuclides	6	1.5
- Sr-90	0.5	0.13
- Sb-125	5	1.3
- Cs-137	2	0.5
- Pu-238 + Pu-239 + Pu-240	0.03	0.008
- Pu-241	0.15	0.04
- Am-241 + Cm-242	0.06	0.015

2.4 Discharges from the THORP stack.

Radionuclide	Annual limit (GBq)	Quarterly notification level (GBq)
- Alpha emitting radionuclides	1	0.25
- Beta emitting radionuclides	280	70
- H-3	4.3 E+04	1.1 E+04
- C-14	870	220
- Kr-85	4.7 E+08	1.2 E+08
- Sr-90	7.8	2
- Ru-106	37	9
- I-129	38	9.5
- Cs-137	11	2.8
- Pu-238 + Pu-239 + Pu-240	0.5	0.13
- Pu-241	13	3.3
- Am-241 + Cm-242	0.39	0.1

And

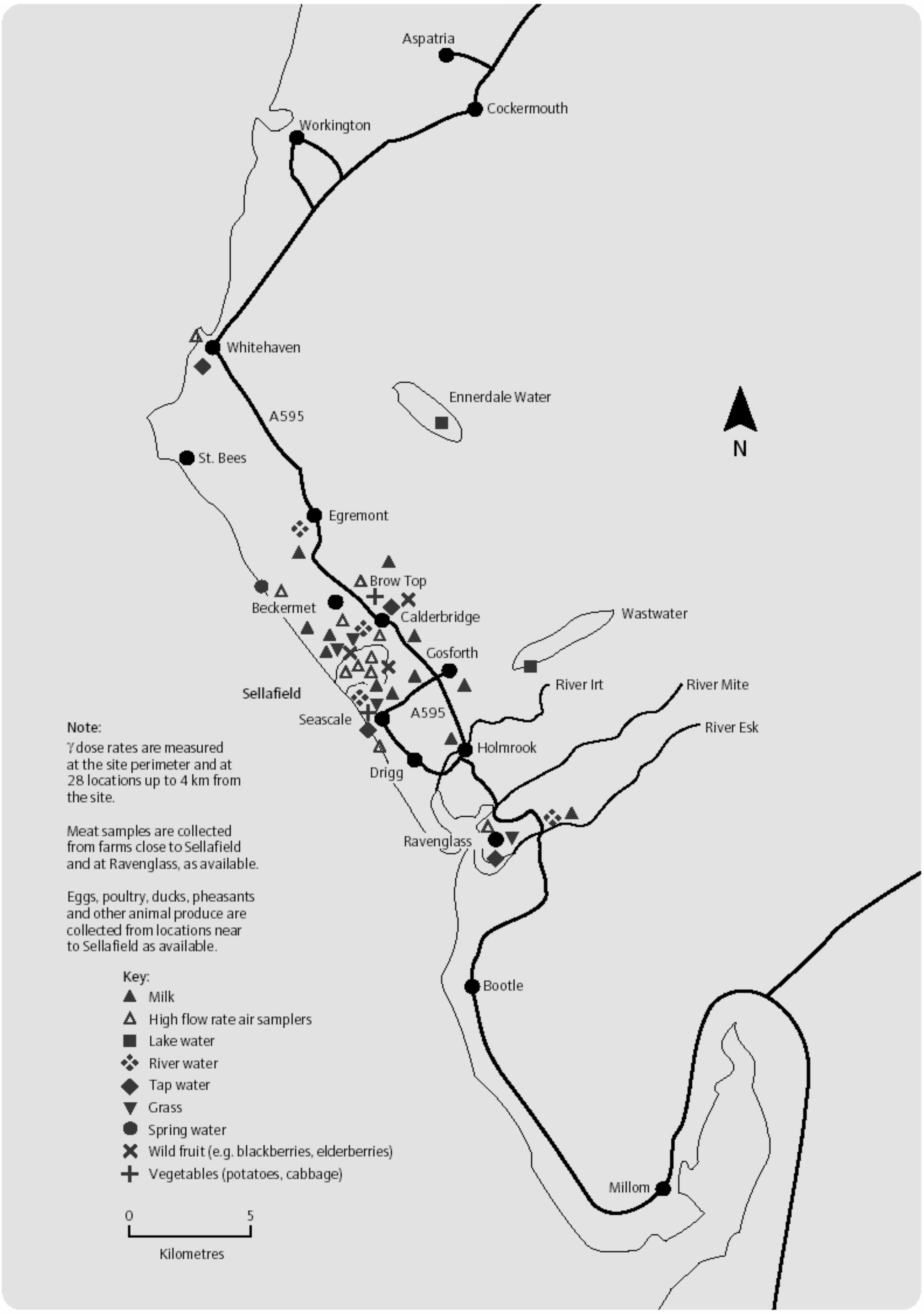
Radionuclide	Annual limit (GBq)	THORP Uranium throughput
- H-3	7.2 E+03	< 100 tonnes
- C-14	145	
- Kr-85	7.7 E+07	
- I-129	7.4	
- H-3	2.2 E+04	between 100 and 400 tonnes
- C-14	440	
- Kr-85	2.3 E+08	
- I-129	22	
- H-3	3.3 E+04	> 400 tonnes (but < 800 tonnes)
- C-14	650	
- Kr-85	3.5 E+08	
- I-129	33	

2.5 Site limits

Radionuclide	Annual limit (GBq)
- C-14	7300
- Ru-106	56
- I-129	70

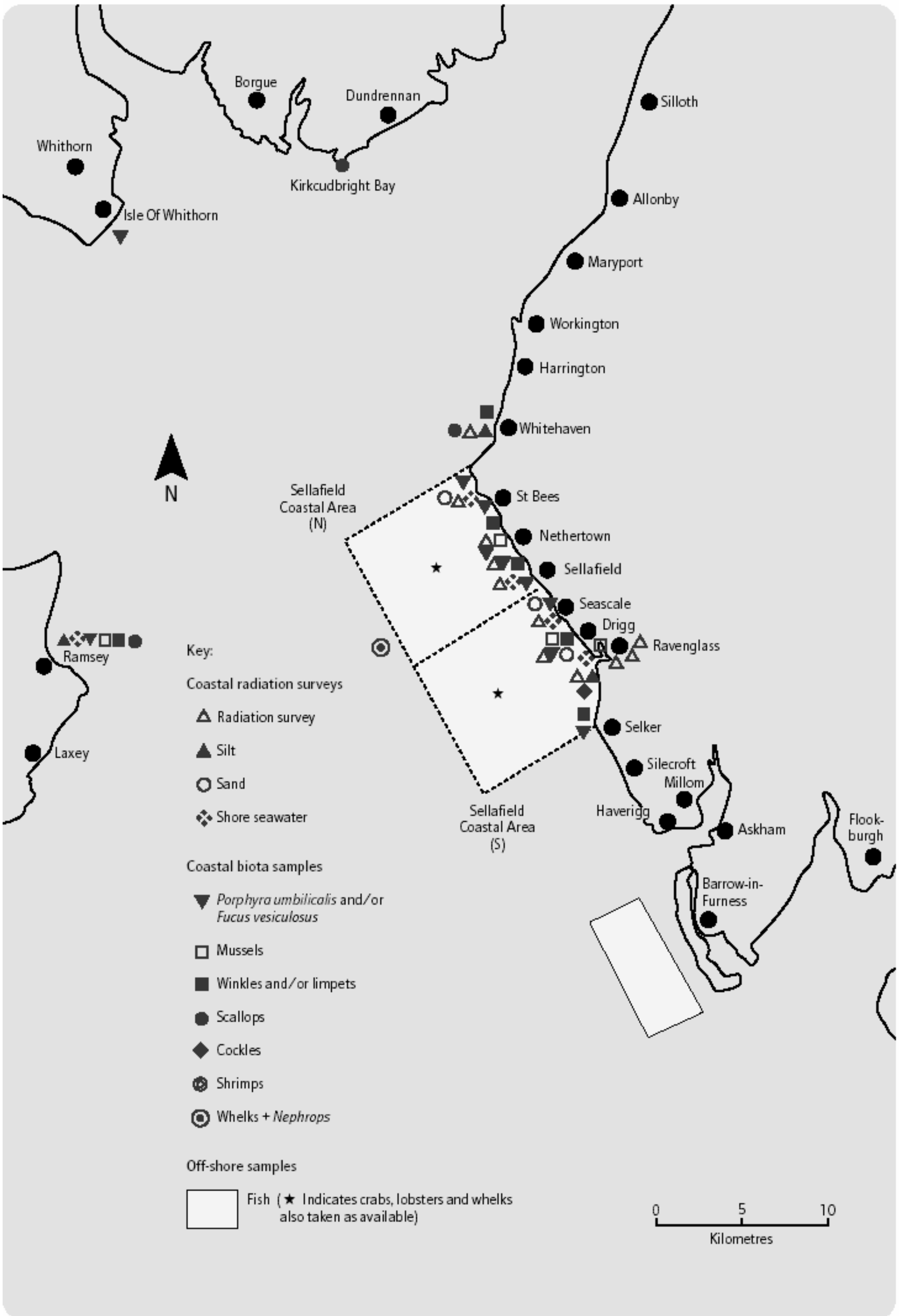
APPENDIX 8

SAMPLING LOCATIONS OF THE BNFL TERRESTRIAL MONITORING PROGRAMME



APPENDIX 9

SAMPLING LOCATIONS OF THE BNFL MARINE MONITORING PROGRAMME



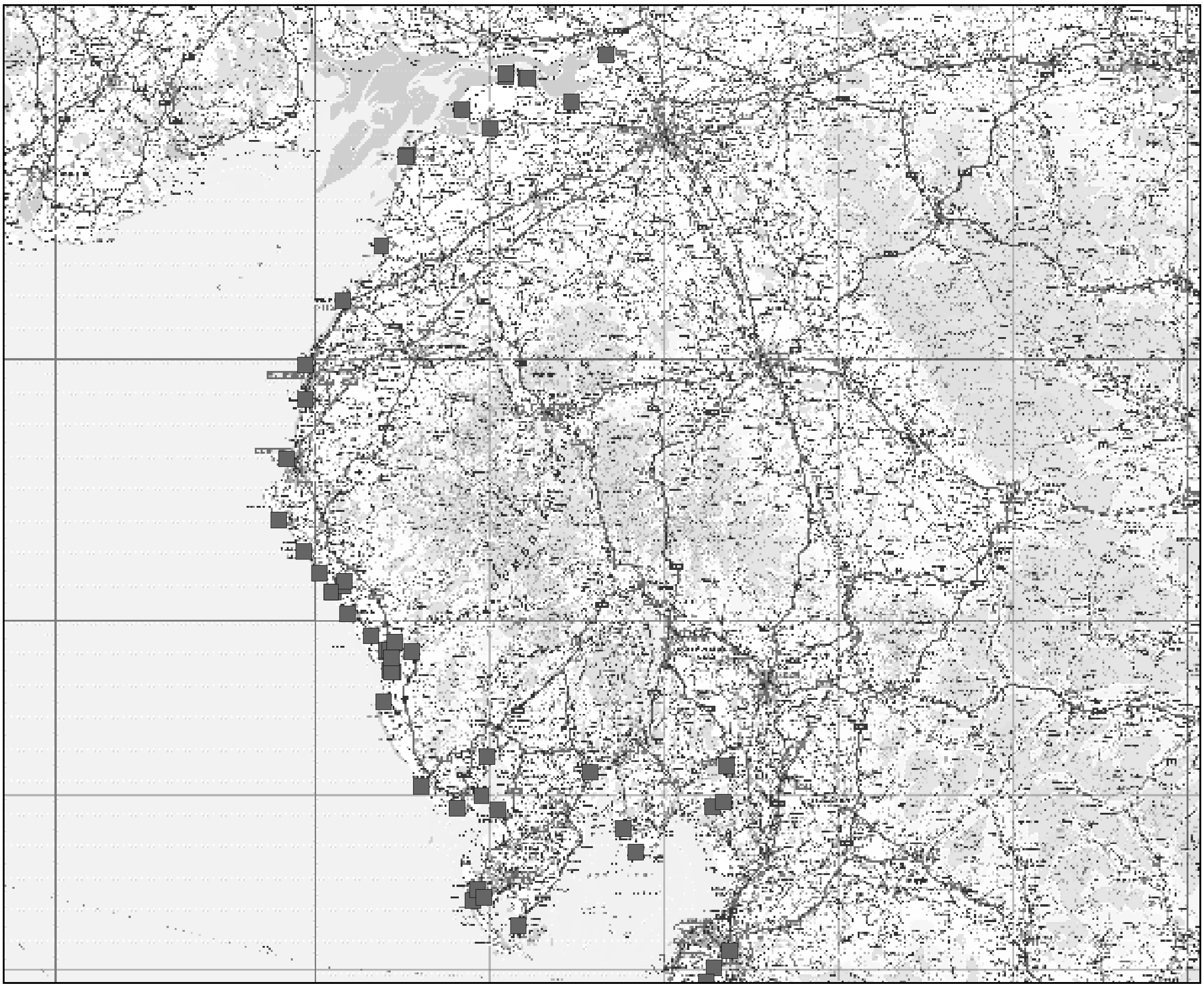
APPENDIX 10

EA - SUMMARY FLOWCHART OF THE MONITORING PROGRAMMES

	Effluent Programme	Environmental Programme
Specification of Monitoring Programme	Responsibility of RMA Team (EA) in association with Nuclear Regulators.	Responsibility of RMA Team (EA) in association with Nuclear Regulators.
Collection of Samples	Nuclear Regulator formally issues CEAR to nuclear site operators which indicates samples to be collected. Collection of some specified samples witnessed by NRPB. Samples stabilised by the operator in accordance with specification.	Collected by Scientifics Ltd (contractor) in accordance with specification.
Transport of Samples to Laboratory	Labelled sample bottles with consignment note delivered by courier service or operators' own transport to NRPB.	Driven by Scientifics Ltd after collection.
Control of Samples in Laboratory and Storage	UKAS procedures for control of samples. Given unique laboratory code.	UKAS procedures for control of samples. Given unique laboratory code.
Analysis of Samples and Quality Control	Analysis in accordance with UKAS accredited methods or methods approved by RMA Team.	Analysis in accordance with UKAS accredited methods or methods approved by RMA Team (EA).
Interpretation and Trending	Examination for unusual results and trends to notify to EA on a quarterly basis.	Examination for unusual results and trends using environmental database, both by contractor and RMLA Team.
Reporting of Results to Environment Agency	Report of results produced quarterly along with a report of trends and unusual results.	Report of results produced quarterly.
Results Acceptance	RMA Team Programme Manager approves acceptance of results following review.	RMA Team Programme Manager approves acceptance of results following review.
Transfer of Results to database & Annual Report "Radioactivity in the Environment"	Electronic reporting of data in effluent monitoring database in early stages of implementation. Data not included in annual report, plan to include summary on web.	Results transferred to the environmental database by Harwell Scientifics Ltd. Onward reported to CEFAS for inclusion in annual report by RMA Team.
Archiving	Paper reports are archived for 5 years. Results will be available electronically in database. Samples are archived for at least 12 months.	Paper reports are archived for 5 years. Results will be available electronically in database. Samples are archived for at least 12 months.

APPENDIX 11

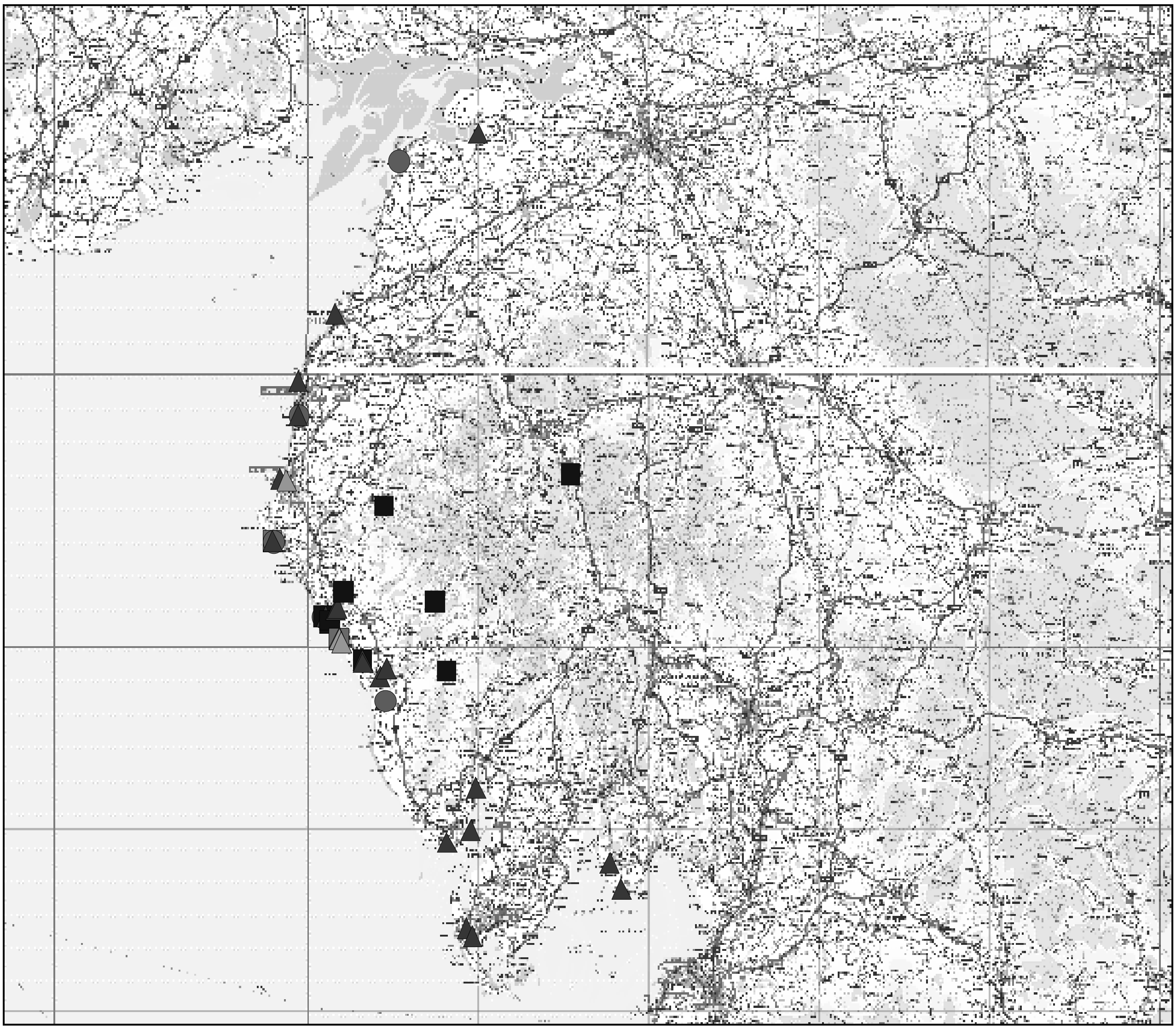
EA - MONITORING LOCATIONS IN THE VICINITY OF SELLAFIELD



Dose rate monitors

APPENDIX 12

EA - SAMPLING LOCATIONS IN THE VICINITY OF SELLAFIELD



- △ Gullypot sediment
- ■ Natural water sources
- ■ Seawater (filtrate)
- ■ Seawater (particulate)
- ● Seaweed
- ▲ Sediment

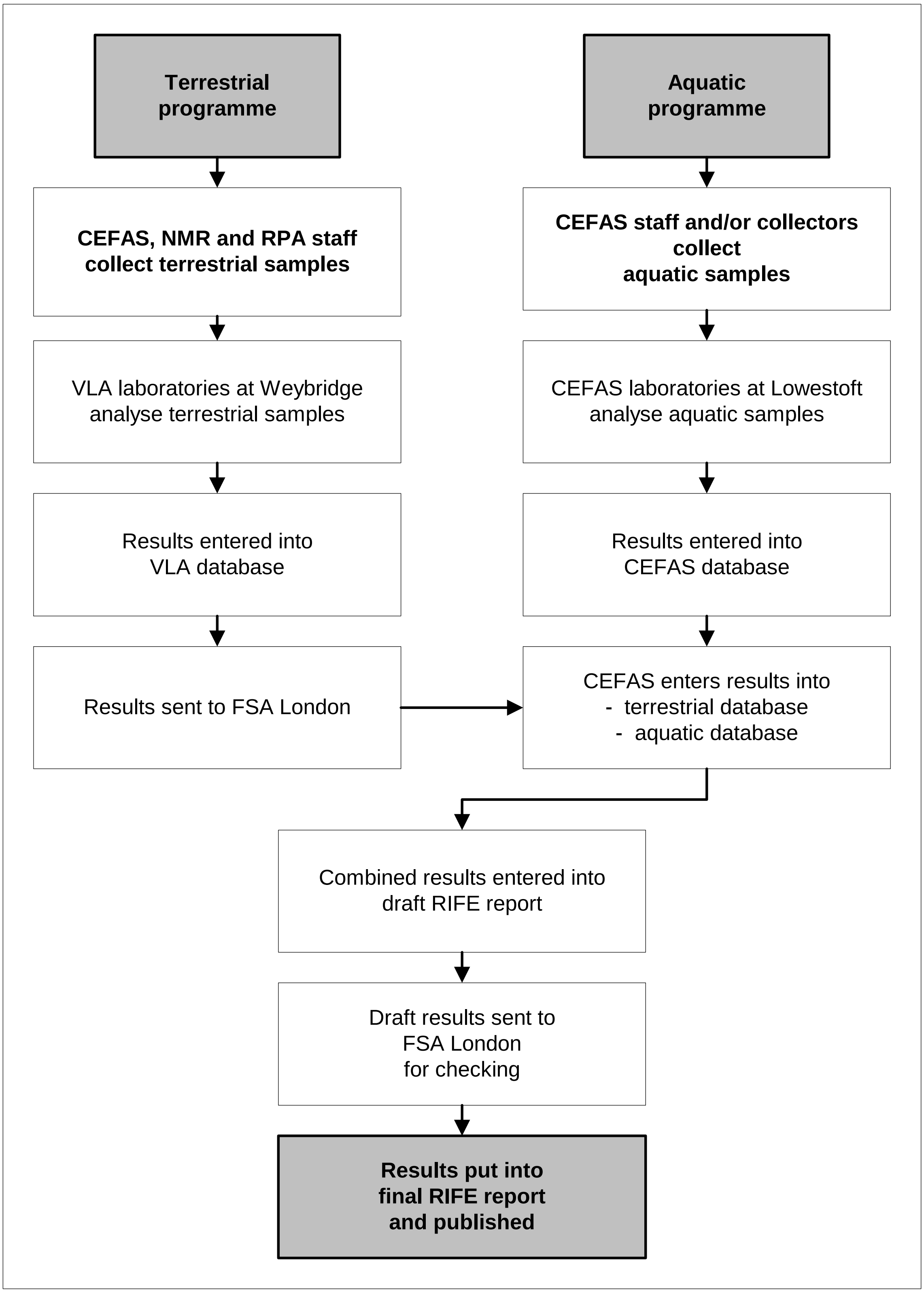
APPENDIX 13

FSA - SUMMARY FLOWCHART OF THE MONITORING PROGRAMMES

	Aquatic Programme	Terrestrial Programme
Specification of Analytical Programme	Responsibility of FSA in consultation with CEFAS (Centre for Environment, Fisheries and Aquaculture Science).	Responsibility of FSA in consultation with VLA (Veterinary Laboratory Agency).
Specification of Sampling Programme	Responsibility of FSA in consultation with CEFAS.	Responsibility of FSA in consultation with CEFAS and RPA (Rural Payments Agency).
Collection of Samples	CEFAS collect samples directly from around sites and undertake dose rate measurements.	CEFAS and RPA collect non-milk samples. National Milk Records (NMR) collect milk samples.
Transport of Samples to Laboratory	Samples either driven to laboratory by CEFAS or sent by overnight courier.	Labelled milk samples are driven to VLA weekly by NMR. CEFAS and RPA send non-milk samples to VLA by courier.
Control of Samples in Laboratory and Storage	UKAS procedures for control of samples. Given unique laboratory code.	UKAS procedures for control of samples. Given unique laboratory code.
Analysis of Samples and Quality Control	Analysis in accordance with UKAS accredited methods or methods approved by FSA.	Analysis in accordance with UKAS accredited methods or methods approved by FSA.
Interpretation and Trending	Examination for unusual results and notification to FSA as analysis is complete.	Examination for unusual results and notification to FSA as analysis is complete.
Reporting of Results to Environment Agency	Results emailed to FSA quarterly.	Updated database of results and sample details sent on CD to the FSA on a fortnightly basis.
Results Acceptance	FSA review results and accepts.	FSA approves acceptances of results following review.
Transfer of data to “Radioactivity in Food and the Environment” report (RIFE).	CEFAS have all data on LIMS database. Quality assured database queries produce data in format for RIFE report. Tables checked by FSA staff.	FSA sends database to CEFAS. Quality assured database queries produce data in format for RIFE report. Tables checked by FSA staff.
Archiving	Any remaining sample is archived indefinitely.	Unused portions of samples are kept for 4 months from the data of analysis unless specified by FSA. Selections of samples with higher-than-normal results from each year are archived for up to 5 years. Results are available electronically.

APPENDIX 14

FSA - STORAGE AND TRANSFER OF DATA IN THE MONITORING PROGRAMMES



APPENDIX 15

FOOD STANDARDS AGENCY - MONITORING LOCATIONS AT SELLAFIELD IN 2002 (EXCLUDING FARMS)[8]

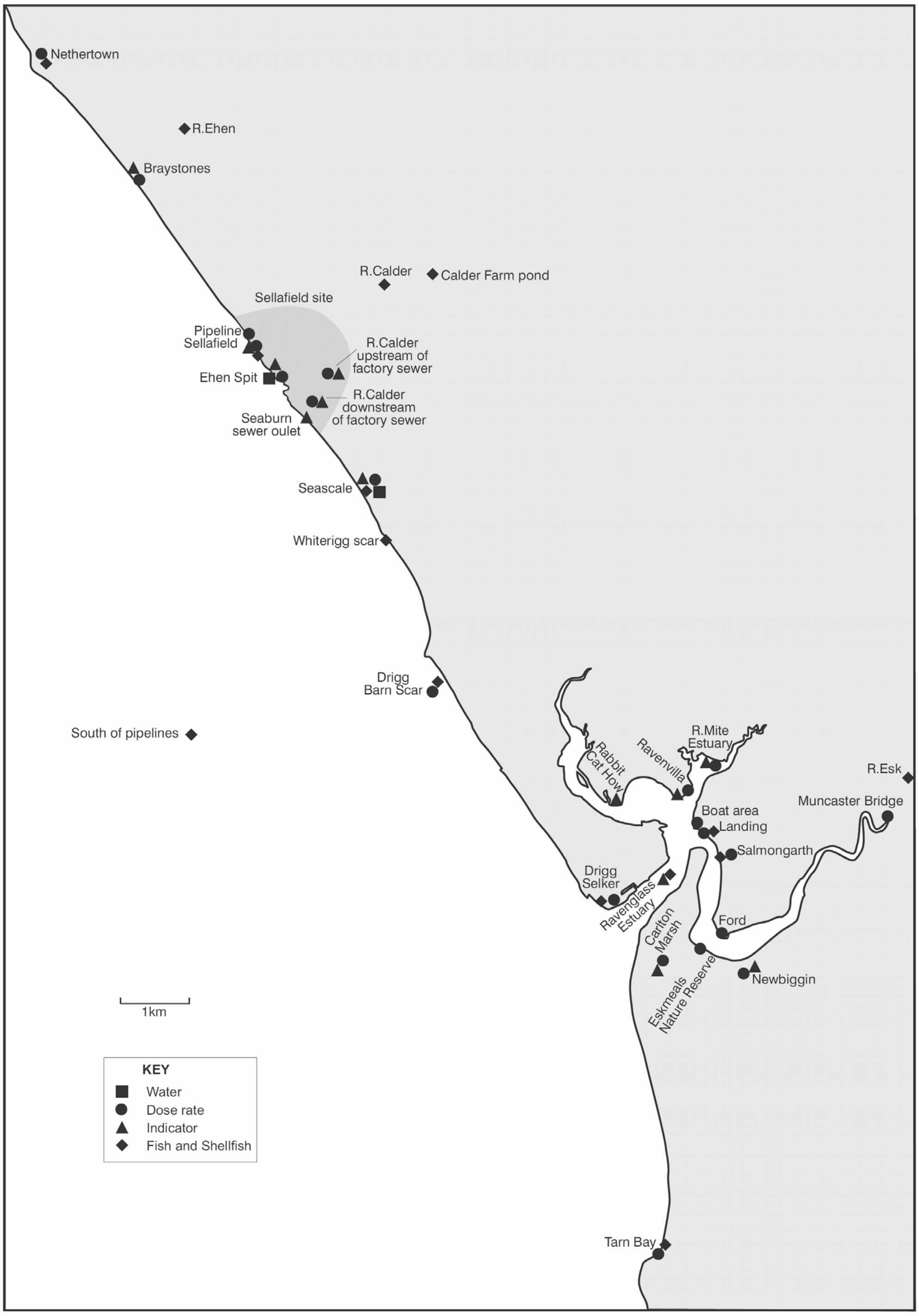


Figure 4.2 Monitoring locations at Sellafield (excluding farms)

8 Map includes also locations from the EA sampling programme.

APPENDIX 16

RADIOLOGICAL MONITORING LABORATORY DETAILS

Monitoring Programme	Laboratory	
Environment Agency Effluent monitoring	National Radiological Protection Board Scottish Centre 155 Hardgate Road Glasgow G51 4LS	
Environment Agency Environmental monitoring	Harwell Scientifics Ltd 551 Harwell Didcot Oxfordshire OX11 0RA	
Environment Agency Air and Rainwater monitoring on behalf of Defra	NNC Limited Winfrith Technology Centre Dorchester Dorset DT2 8DH	
Environment Agency Public Drinking Water monitoring on behalf of DefraA	Up to end 2003: Harwell Scientifics Ltd 551 Harwell Didcot Oxfordshire OX11 0RA	2004 onwards: Laboratory of the Government Chemist Queens Road Teddington Middlesex TW11 0LY
Food Standards Agency Aquatic monitoring programme	The Centre for Environment, Fisheries & Aquaculture Science Lowestoft Laboratory Pakefield Road Lowestoft Suffolk NR33 0HT	
Food Standards Agency Terrestrial monitoring programme	Veterinary Laboratories Agency - Weybridge New Haw Addlestone Surrey KT15 3NB	
Food Standards Agency Aquatic monitoring programme	CEFAS Laboratory White Strand Whitehaven Cumbria CA28 7LY	

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