EUROPEAN COMMISSION
DIRECTORATE-GENERAL ENERGY

Directorate D – Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

SELLAFIELD NUCLEAR REPROCESSING PLANT
CUMBRIA
UNITED KINGDOM

23 to 27 August 2010

Reference: UK-10/05

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Installations for monitoring and controlling radioactive discharges and for on-site surveillance of the environment during normal operations of the Sellafield Nuclear Fuel Reprocessing Plant
SITE:	Sellafield, Cumbria, United Kingdom
DATE:	23 to 27 August 2010
REFERENCE:	UK-10/05
INSPECTORS:	Constant Gitzinger(Head of team) Eberhardt Henrich Erich Hrnecek
DATE OF REPORT:	2011-04-18
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TABLE OF CONTENTS

TECHNICAL REPORT

ABBREVIATIONS

AECWP	Aerial Effluent Control Working Party
APP	Accountancy Point Plant
BeGe	Beryllium window Germanium (radiation measurement)
BNFL	British Nuclear Fuels plc
BNGSL	British Nuclear Group Sellafield Limited
BPM	Best Practicable Means
BPT	Break Pressure Tank
BST	BST (British Summer Time)
CA	Certificate of Authorisation
CCR	Central Control Room
CEAR	Compilation of Environment Agency Requirements
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFA	Conditions For Acceptance
CoP	Code of Practice
DCG	Discharge Co-ordination Group
DECC	Department of Energy and Climate Change
DG ENER	Directorate General Energy (of the European Commission)
DG TREN	(former) Directorate General Energy and Transport (of the European Commission)
DOG	Dissolver Off Gas
DOS	(Microsoft) Disk Operating System
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 (Now Northern Ireland Environment Agency (NIEA)
EMA	Environmental Monitoring and Assessment group (BNFL)
EMP	Environmental Monitoring Programme
ENTRAP	European Network of Facilities for the Quality Checking of Radioactive Waste Packages
EPR	Environmental Permitting Regulation
EU	European Union
FIDLER	Field Instrument for Detecting Low Energy Radiation
FRP	Floc Retrieval Plant
FSA	Food Standards Agency
GM	Geiger-Müller (radiation measurement)
GMT	Greenwich Mean Time
GSL	Geoffrey Schofield Laboratories
HEPA	High Efficiency Particulate in Air (air filter)
HiVol	High Volume (air sampler)
HMIP	Her Majesty’s Inspectorate of Pollution (now Environment Agency)
HPGe	High Purity Germanium (radiation measurement)
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectrometry
ISO	International Standardization Organization

JRC	Joint Research Centre (DG of the EC)
LAEMG	Low Active Effluent Management Group
LEC	Liquid Effluent Co-ordinator (BNFL)
LECWP	Liquid Effluent Control Working Party (BNFL)
LEGe	Low Energy Germanium (radiation measurement)
LEMS	Liquid Effluent Management System
LGC Ltd	Laboratory of the Government Chemist Ltd
LLD	Lower Limit of Detection
LOD	Limit Of Detection
LSC	Liquid Scintillation Counter
LSN	Laboratory Sample Number
LWR	Light Water Reactor
MAC	Medium Active Concentrates
MAFF	Ministry of Agriculture, Fisheries and Food (now DEFRA)
MCERTS	Monitoring Certification Scheme
MDA	Minimum Detectable Activity
NaI(Tl)	Sodium Iodide, Thallium activated (radiation measurement)
NDA	Nuclear Decommissioning Authority
NIEA	Northern Ireland Environment Agency (formerly Environment & Heritage Service (Northern Ireland)
NII	Nuclear Installations Inspectorate
QAAM	Quality Assured Analytical Method
QA	Quality Assurance
REM	Radioactivity Environmental Monitoring (EC data base at JRC Ispra)
RIFE	Radioactivity In Food and the Environment (report)
RMA	Radiological Monitoring and Assessment (team within the Nuclear Regulatory Group of the Environment Agency)
RQNL	Rolling Quarterly Notification Levels
RSA	Radioactive Substances Act
SCO	Stack Co-ordinator
SEPA	Scottish Environment Protection Agency
SETP	Segregated Effluent Treatment Plant
SIXEP	Sellafield Ion Exchange Effluent Plant
SL	Sellafield Limited
SLIMS	Sellafield Laboratory Information Management System
SMP	Sellafield MOX Plant
SSP	Sellafield Site Procedure
STP	Solvent Treatment Plant
TEROMAN	Sellafield site maintenance management system (database)
THORP	Thermal Oxide Reprocessing Plant
TLD	ThermoLuminescence Dosimetry (radiation measurement)
TPB	Tetraphenylphosphoniumbromide
UK	United Kingdom
UPS	Uninterruptible Power Supply
UKAS	United Kingdom Accreditation Service
VLA	Veterinary Laboratory Agency
WQCL	Waste Quality Checking Laboratory (of the EA)

1 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 (DG ENER; formerly Directorate-General for Energy and Transport - DG TREN) and more in particular its Radiation Protection Unit (ENER D.4) is responsible for undertaking these verifications.

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

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

Taking into account previous bilateral protocols, a Commission Communication has been published in the Official Journal on 4 July 2006 with a view to define some practical arrangements for the conduct of Article 35 verification visits in Member States.

For the purpose of such reviews, on several occasions verification teams from the EC visited the Sellafield site located on the coast of Cumbria. At the time of the visit in 2004 the site was operated by British Nuclear Fuels plc (BNFL), at the current verification by DG ENER it was owned by the Nuclear Decommissioning Authority (NDA) and operated by Sellafield Ltd..

The visit also included meetings with the Environment Agency (EA) and the Food Standards Agency (FSA).

The present report contains the results of the verification team's review of relevant aspects of the environmental surveillance at 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.

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), EARP (Enhanced Actinide Removal Plant) and SETP (Segregated Effluent Treatment Plant).
- The implementation of the statutory "on site" environmental radioactivity monitoring programme as performed by the operator.

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

- The operator's effluent laboratory, including aspects of quality assurance and control as well as document control.

The monitoring by the operator of levels of environmental radioactivity in the marine, terrestrial and aquatic environment around the site was not included in this verification, as was also not the independent environmental monitoring programme as performed by the UK competent authorities (Environment Agency and Food Standards Agency). However, some aspects were discussed during the visit.

The present report is also based on information collected from documents referred to in Chapter 2 and from discussions with various persons met during the visit, also listed in Chapter 2 below.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission's decision to request the conduct of an Article 35 verification was notified to the UK Government on 15 March 2010 (letter referenced ENER.D4 CG/jf D(2010)55310, addressed to the UK Permanent Representation to the European Union). The UK Government subsequently designated the Department of Energy and Climate Change (DECC) to lead the preparations for this visit.

2.2 DOCUMENTS

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

2.3 PROGRAMME OF THE VISIT

The EC and the Department of Energy and Climate Change (DECC) 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 and the Commission Communication published on 4 July 2006 with a view to define some practical arrangements for the conduct of Article 35 verification visits in Member States. During the information meeting presentations were given on the following topics:

- Government approach to Nuclear Sites
- Radioactive Substances Act 1993 (RSA93) Authorisations and Environmental Permitting Regulations 2010 (EPR2010)
- The Sellafield site – introduction
- Discharge monitoring at Sellafield
- Environmental monitoring at Sellafield
- Groundwater monitoring at Sellafield
- EA/FSA independent monitoring Programmes

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.

2.4 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:

Nuclear Decommissioning Authority (NDA):

Alyson Armett

Environment Agency (EA):

Dr Rob Allott	Sellafield Team Leader
Dr Matthew Emptage	Nuclear Regulator
Mr Stephen Tandy	Nuclear Regulator
Ms Nancy Lawton	Nuclear Regulator

Food Standards Agency (FSA):

Dr. Selwyn Runacres

Sellafield Limited:

Fran Williams	
Phil Stones	
Jim Desmond	
Tim Parker	
Katherine Eilbeck	Technical Lead, Land Quality
Jim Stothers	Head of Technical, Effluent and Encapsulation Plants
Tony Sharp	THORP Stack Co-ordinator
Clare McCourt	THORP Deputy Stack Co-ordinator
Jon Roll	THORP Area Environmental Co-ordinator
Matthew Lee	THORP Environmental Performance Manager
Kathryn Goldthorpe	THORP Environmental Performance Manager
Chris Spence	THORP Liquid Effluent Co-ordinator
Jim Field	THORP Manufacturing Support manager
Andrew Howis	EAGLE Discharge Records Manager
SeanTapodi	Analytical Services, Manager Quality System
Mary Herberts	Analytical Services, Radiochemistry Laboratory Manager
Kevin Hindmarch	Analytical Services, Radiochemistry Laboratory Analyst
Scott Mossop	EARP and SETP, Environmental Co-ordinator
Lucy Heywood	EARP Liquid Effluent Coordinator
Jason Carey	LAEMG Shift Co-ordinator

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

3 COMPETENT AUTHORITIES & LEGAL BACKGROUND

3.1 INTRODUCTION

Up until April 2010 within England, Wales and Scotland, the Radioactive Substances Act 1993 (RSA 93) provided the framework for controlling the generation and disposal of solid, liquid and gaseous radioactive waste so as to protect the public and the environment. From the 6th of April 2010 in England and Wales RSA 93 has been replaced by the Environmental Permitting Regulations 2010 (EPR 2010). In particular, these regulations require prior permitting for the disposal or discharge of radioactive waste to the environment. Responsibility for granting a permit rests with the Environment Agency (EA) in England and Wales.

The Environment Agency formally requires nuclear site operators with significant radioactive waste discharges to undertake monitoring of the environment on and around their sites. This monitoring is specified in detail within the Compilation of Environment Agency Requirements (CEAR) documents, which accompany the radioactive waste discharge permits.

The Environment Agency 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 Environment Agency in 1996, radioactive waste discharge authorisations (now replaced by permits) 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 Environment Agency. This responsibility was transferred to the Food Standards Agency (FSA) in April 2000. Under the Environmental Permitting Regulations (EPR 2010) this consultation is no longer statutory, but undertaken through a Working Together Agreement.

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 permits to discharge radioactivity.

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

The responsibilities for independent radiological monitoring undertaken by the Environment Agency 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

Currently the Working Together Agreement between the Environment Agency and the Food Standards Agency specifies these responsibilities.

Regular programme interactions are undertaken between the Agencies along with regular formal liaison meetings. This all facilitates 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 Environment Agency and Food Standards Agency.

3.2 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 the permits granted by the Environment Agency under RSA 93 or EPR 2010. The Permits 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.

3.3 INDEPENDENT VERIFICATION BY THE REGULATOR

The Environment Agency 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 Environment Agency is the Laboratory of the Government Chemist Ltd (LGC Ltd) at their laboratories in Teddington, England, using analytical methods most of which are accredited by UKAS. Collection of spot samples for the Environment Agency is in most cases witnessed by LGC (Laboratory of the Government Chemist – the current EA contractor for such activities) staff on behalf of the Environment Agency. Samples are sealed to ensure the chain of custody.

3.4 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)

Note: On 1 October 2004 the authorisation listed above were replaced by a single integrated authorisation (document BX9838). A revised permit was issued on 1 April 2010 (BX9838-CE1369).

4 THE SELLAFIELD SITE – SHORT DESCRIPTION OF PLANTS VISITED

Basically, the Sellafield site serves to reprocess nuclear fuel of various origins and to manage nuclear waste from historical operations. Nuclear power plants that were operated at the site (e.g. Windscale) have stopped operation several years ago and to a large part currently are under decommissioning.

4.1 THERMAL OXIDE REPROCESSING PLANT THORP

The Thermal Oxide Reprocessing Plant (THORP) was developed in the early 1970's as the then responsible body, British Nuclear Fuels Ltd. (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. Currently THORP is owned by the Nuclear Decommissioning Authority (NDA) and operated by Sellafield Ltd (which is the site licensee company). 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 it is scheduled for reprocessing. LWR fuel must remain within the pond for a period of at least three and a half years. Such storage periods are sufficient to allow 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 (EARP).

Within the Head End section of the plant the spent fuel is chopped into smaller pieces ready for dissolution. The spent fuel is dissolved in nitric acid, leaving the pieces of fuel cladding as remains. During this process off-gases are produced which are extracted within the Dissolver Off Gas (DOG) system for treatment/abatement prior to release to the 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 the customer. Supernatant liquors from this process are discharged to sea after sampling and monitoring.

The purpose of Chemsep is to separate 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 monitored, sampled for analysis, and discharged to the atmosphere via the THORP stack.

4.2 ENHANCED ACTINIDE REMOVAL PLANT (EARP)

The Enhanced Actinide Removal Plant (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 on addition of sodium hydroxide in EARP forms a ferric floc.

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 SEGREGATED EFFLUENT TREATMENT PLANT (SETP)

The Segregated Effluent Treatment Plant (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.

4.4 BREAK PRESSURE TANK (BPT)

The Break Pressure Tank (BPT) receives effluent streams from plants on site (e.g. SETP and EARP) 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 THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

5.1 INTRODUCTION

5.1.1 Aims

One of the conditions of the permit 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 radio-nuclides in this area. The "off site" environmental monitoring was not part of this verification.

5.2 OPERATOR

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. For details see Chapter 5.5. The operators (off-site) environmental monitoring programme was not included in the 2010 verification.

In parallel to the operator programme the competent authorities run complementary EMPs, partly with the aim to verify the operator’s results.

5.3 ENVIRONMENT AGENCY MONITORING PROGRAMMES

The Environment Agency's environmental monitoring programmes were not included in the 2010 verification. However, for sake of clarity, a short description is given here, based on information received.

The Environment Agency carries out the following routine monitoring programmes:

- Monitoring of effluent samples provided by nuclear site operators
- Monitoring of the environment, primarily in the vicinity of nuclear sites
- Waste quality checking of low level radioactive waste disposals
- Air and rainwater in the United Kingdom (on behalf of DECC)
- Drinking water sources in England and Wales (on behalf of DECC).

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

All the Agency programmes are managed by the Agency's Radiological Monitoring and Assessment team (RMA team) within the Nuclear Regulatory Group. An Agency Management System procedure for 'Routine Radiological Monitoring' has been developed.

The monitoring programmes are specified through liaison with Environment Agency Nuclear Regulators (who are responsible for regulating the permitted premises) and RMA team Programme Managers. The programmes are tailored to the individual site permits with regard to what types of samples are collected and nuclides analysed.

However, where there is commonality the programmes are designed to be consistent. The required samples/nuclides and detection limits are specified in the monitoring programme contracts. These programmes are then competitively tendered.

Quality Assurance Arrangements

To ensure the standard of the monitoring data the Environment Agency requires the contractors it uses for its monitoring programmes to be accredited by the UK Accreditation Service (UKAS) to ISO 17025. Further the Environment Agency has a Monitoring Certification Scheme (MCERTS) which has been set up to deliver quality environmental measurements and under this scheme a performance standard for the radio-analytical testing of environmental and waste waters is being developed, which will then be used in conjunction with UKAS accreditation. The contractors all hold 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.

5.3.1 Effluent Monitoring Programme (nation wide)

The Environment Agency 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. Arrangements are also in place for the independent contractor to witness the taking of some samples and for these to be sealed with tamper evident seals before transportation to and analysis at the independent laboratory. Currently the analyses are undertaken by Laboratory of the Government Chemist Ltd (LGC Ltd) at their laboratories in Teddington, England using analytical methods which are accredited by UKAS.

5.3.2 Environmental Monitoring (nation wide)

The Environment Agency undertakes a programme of monitoring of 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 (and reasons for sampling and analysis given by the EA) are as follows:

- Sediment - These are a potential source of exposure through external radiation, inhalation and inadvertent ingestion during recreational activities. Results are also used for the validation of reported discharges and sea dispersion modelling.
- Seaweed - Good indicator of recent discharges, less transient than seawater, but not as long as sediment. More homogenous than sediment. Particularly good indicator for certain radio-nuclides (e.g. iodine and technetium).
- Seawater - Precursor to incorporation of radio-nuclides in sediment, fish and shellfish. Results also used for the validation of reported discharges and sea dispersion modelling.
- Grass/Herbage - Food source for livestock which provide products for human consumption; a particularly important exposure pathway being milk. Results are also used for the validation of reported discharges and environmental transfer modelling. Detection of abnormal releases. Can be more sensitive than milk since cows graze larger areas.
- Soil - Important part of environmental transfer pathway to milk. Root zone (i.e. top few centimetres) is the relevant zone. Less variability than grass, thus better long term measure for state of the environment. Enables measurements of total deposition of long-lived radio-nuclides to be made. Important background measurement in case of incident.
- Gullypot sediment - Enable detection of fugitive emissions, such as dust and contamination on vehicles.
- Natural water - Potential source of exposure through consumption of water, including inadvertent consumption during recreational activities. Indicator of abnormal releases and land contamination.
- Drinking water - Secondary consumption radiological exposure pathway.

Currently the environmental monitoring is carried out by *Environmental Scientifics Group Limited* (Oxfordshire), in accordance with Agency specifications. The methods employed are accredited by UKAS and are well documented.

The selection of sampling or 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. The majority of monitoring is focused around the nuclear licensed sites.

Samples are normally taken quarterly and analysed by gamma ray spectrometry and in some cases, chemical extraction and separation followed by beta counting or alpha spectrometry. Sampling techniques are put down in respective procedures.

Measurements of gamma dose rates above beach, inter-tidal and river bank areas are made by measuring the absorbed dose rate in air (µGy/h) one metre above ground. A *Mini-Instruments Environmental Meter type 6-80* fitted with an energy-compensated Geiger-Müller tube type *MC-71* was used for this purpose.

Contact beta/gamma monitoring of debris at the most recent strand line on the beach or river bank is also carried out. A *Mini-Instruments series 900 mini monitor* with a beach monitoring probe is used for this purpose.

For fishing equipment (for example nets and pots) external beta doses are measured on contact, using *Berthold LB 1210B* contamination monitors. These portable instruments are calibrated against recognised reference standards. This work recently transferred from the FSA is undertaken by CEFAS for consistency.

5.3.2.1. 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 radio-nuclides in air and the levels of radioactivity deposited in rainwater. A detailed description of the programme and the results are published annually. The results are provided to DECC for submission to the European Commission under Article 36 of the Euratom Treaty.

Currently this analysis is undertaken by the Health Protection Agency (Radiation and Environmental Monitoring), Glasgow, Scotland. Most methods used are accredited by UKAS. The seven sampling locations in the UK are Chilton (Oxfordshire), Aberporth (Dyfed), Conlig (County Down, Northern Ireland), 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. Filters are changed weekly at each location. 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. The analytical methods used are laid down in respective documents.

5.3.2.2. 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. The water companies provide samples of water for analysis. The analyses will be undertaken by LGC Ltd, Teddington, using methods that are UKAS accredited. The results are also provided to DECC for submission to the European Commission under Article 36 of the Euratom Treaty. These results also provide information to the water companies on the activity concentrations of radio-nuclides in raw water sources and supplementary data to the Environment Agency on exposure of the public.

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 radio-nuclides. Details of the analytical methods employed by the contractor LGC are laid down in respective documents.

5.3.3 Transmission of Monitoring Data and Records

The contractors who undertake the Environment Agency’s monitoring programmes have quality management procedures in place to provide an audit trail of results through to transmission to the Environment Agency. These procedures form part of the laboratories UKAS accreditations. Results are provided as a combination of electronic and paper reports to the Agency.

The Environment Agency holds an environmental radiological monitoring database that provides the repository for the Environment Agency’s monitoring data. This database was originally developed by *AEA Technology* in accordance with the 'TickIT' scheme. Further development has been undertaken by the RMA Team to enable direct electronic transfer of the data from the contractor to the database. A similar effluent monitoring programme database also exists which is the repository for the comparison results between the operator and our independent laboratory. This is annually updated, however on a quarterly basis results are distributed to the operators through a comparisons spreadsheet, to enable an ongoing assessment of performance and any issues to be addressed.

5.3.4 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. This judgement is not only based on reviewing the actual results, but also takes into account detailed knowledge of other factors (local variation in sediment grain size and characteristics at a particular location).
- By utilising facilities in the environmental radiological monitoring database to look at action levels and trends. Action levels are calculated for each sample/location/radionuclide combination based on particular confidence levels associated with historical results (e.g. 99.9% which equates to 1 in 1000). Reports can be run to select those results for a particular year which exceed the appropriate action level.

Where results are considered "highly significant" the contract laboratory notifies the Agency Programme Manager immediately by e-mail/fax and usually by telephone also. This procedure is also followed for beach strandline contact beta/gamma monitoring when a "hot particle" is found. In such cases the Programme Manager immediately informs the relevant Agency Nuclear Regulator.

The action level facility of the database is also used to identify results which may not be "highly significant" but nevertheless are regarded as "interesting" or "noteworthy". Results exceeding the chosen action level can be listed or presented as graphs. Also the database allows trend graphs to be produced – either selecting a standard set or choosing an individual location, matrix and nuclide combination. Use of this system is still augmented by the use of experience and judgement.

5.3.5 Waste Quality Checking

Independent checks are also carried out on solid low-level radioactive waste destined for land disposal at the site operated by the Low Level Waste Repository Ltd at Drigg in Cumbria. This site was not included in the 2010 verification. However, for sake of completeness, a short description is given here, based on information received.

Consignments of waste are seized by inspectors and sent to the Agency's Waste Quality Checking Laboratory (WQCL) at Winfrith in Dorset (see Table 1). The results provide checks on the descriptions and radioactive contents of wastes declared by site operators and insights into their QA and monitoring procedures. Currently, staffing and operation of the laboratory is carried out by Amec. WQCL are members of the European Network of Facilities for the Quality Checking of Radioactive Waste Packages (ENTRAP).

5.4 FOOD STANDARDS AGENCY MONITORING PROGRAMMES

The Food Standards Agency's radiological monitoring programme was not included in the 2010 verification. However, for sake of clarity, a short description is given here, based on information received.

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 is conducted in the site's immediate vicinity. However, radio-nuclides (such as Tc-99) discharged in liquid effluent from Sellafield Ltd 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 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. The terrestrial programme deals with contamination on land, which is dominated by disposals to the atmosphere. Work is also undertaken on general diet surveys, which provide information on radio-nuclides in the food supply to the whole population.

The main aim of the programme is to monitor the diet of consumers who live or work near nuclear sites in order to estimate exposures for those small groups of people who are most at risk from disposals of radioactive waste. By identifying and monitoring the representative person (formally a critical group of consumers) who might potentially receive the highest dose and ensuring that this person does not exceed the EU dose limits, the Food Standards Agency strategy assumes that all other consumers in areas which have lower concentrations of radioactivity would also be protected. Using this strategy, the programme also serves to address the concerns of stakeholder groups and other Member States.

For the programmes samples are collected from the environment and analysed for their radio-nuclide content in a laboratory.

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: (i) gamma-ray spectrometry; and (ii) radiochemical methods. The latter are only used when there is clear expectation that information is needed on specific radio-nuclides.

Two laboratories analyse samples:

1. CEFAS - Centre for Environment, Fisheries and Aquaculture Science
    - Lowestoft Laboratory - Analysis of all aquatic samples;
    - Whitehaven Laboratory – Collection and some limited preparation of samples prior to their dispatch to the main laboratory at Lowestoft;
    - Collection of some terrestrial samples.
2. VLA - Veterinary Laboratory Agency, Surrey - Gamma spectrometry and radiochemistry of all terrestrial samples.

Each laboratory operates a quality control procedure to UKAS, see below. Inter-comparison exercises are also undertaken with other laboratories in the UK and in Europe.

5.5 MONITORING AROUND THE SELLAFIELD AREA

5.5.1 Sellafield Ltd. –Operator's monitoring programme

5.5.1.1. On-site

On-site environmental radiological monitoring by the operator covers ambient gamma dose rate, ambient gamma dose (using TLD), air activity, deposition (rain water), grass and soil contamination, and ground water activity.

5.5.1.2. Off-site

Only the "on-site" environmental radiological monitoring by the operator was part of this verification. However, for sake of completeness, a short description is given in this chapter.

The operator's 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 operator's 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)

5.5.1.3. Environmental monitoring laboratory of the operator

The verification of 2010 did not include the measurement laboratory that deals with environmental samples on behalf of the operator. The relevant tasks were taken up by an external contractor (Babcock's Nuclear Environmental Laboratory, based at the Westlakes Science and Technology Park).

5.5.2 Environment Agency Monitoring

The Environment Agency's radiological monitoring programme was not included in the 2010 verification. However, for sake of clarity, a short description is given here, based on information received.

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

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, with beta dose rates made at a few locations.

The verification team was informed that with regard to the plants the EA effluent monitoring programme at Sellafield consists of analysing quarterly bulk samples (both stabilised and non-stabilised) of aqueous liquid effluent from SIXEP (Sellafield Ion Exchange Effluent Plant), SETP, THORP (feed pond and dissolver off gas), EARP, the factory sewer and Magnox separation area. Additionally spot compliance samples are taken from these plants except the latter two.

Bubbler liquor samples are also analysed from the main 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 Low Level Waste Repository (at Drigg) pipeline (not subject of this verification). Additionally in 2006 a check programme for groundwater samples from Sellafield "on-site" boreholes was initiated.

According to the information received, a recommendation given at the Euratom Article 35 verification visit to the Dungeness area in November 2000 with regard to collection of independent samples was taken up by requiring the check monitoring contractor to witness operators collecting samples. EA judged that a risk-based approach should be adopted whereby samples for effluent discharges with low/negligible radiological impact need not be witnessed. This approach was also introduced for the Sellafield site. The Environment Agency conducted a review of the check monitoring programme to see how the witnessing element could be accommodated. Many samples are “spot” or “grab” samples taken at the time of a tank discharge – such samples are readily amenable to witnessing by the check monitoring contractor. However, there are many samples which are “bulks” collected over a particular period of time (eg a calendar quarter); these samples are often collected automatically – eg by flow proportional sampler. Such samples could not be witnessed by the check monitoring contractor. As bulk samples serve an important purpose – they provide a measure of the radioactivity discharged over a particular time period – they have been retained on the programme, but they have been supplemented with witnessed spot samples from the key sites and effluent streams. The original intention was for the check monitoring contractor to take witnessed samples away with them on the day of sampling. However, EA recognised that this may not be feasible in some instances (eg due to the need for samples to be cleared through health physics checking procedures). Hence, the contractor carries a stock of tamper-evident numbered sealing clips which are used to seal bags containing the sample bottles once prepared. Operators are required to dispatch samples to the analytical laboratory as soon as possible after the day of sampling.

5.5.3 Food Standards Agency Monitoring

The Food Standards Agency's radiological monitoring programme with regard to the Sellafield site was not included in the 2010 verification. However, for sake of completeness, an overview description is given here, based on information received.

5.5.3.1. Sellafield Aquatic Programme

The main components of the Sellafield aquatic programme are sampling and laboratory analysis of a wide range of seafood and indicator materials. 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. Knowledge of such pathways is gained from surveys of local peoples’ diets and habits. The most recent comprehensive survey of habits for the Sellafield area was 2008, although minor assessments of habits are undertaken each year. As a consequence the scope of the programme varies from year to year, according to local circumstances. For example, in 2008 there was no reported consumption of uncommon seafood (such as sea mice) caught as a by-catch of fishing in the Sellafield area, although this practice has been observed in the past and the potential pathway is kept under review in case future habit surveys show that this practice has resumed.

5.5.3.2. Terrestrial Programme around Sellafield

The main focus of the terrestrial programme around Sellafield is the sampling and analysis of foodstuffs that may be affected by disposals to atmosphere, although 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 disposals, 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. The last habit survey for Sellafield was undertaken in 2008 and changes were implemented to the sampling programme as required. Even minor pathways of radioactivity through the food-chain are monitored or estimated, for example the local consumption of vegetables grown in soil conditioned with seaweed, the dose due to the consumption of sheep grazing seaweed shores in the Scottish Isles and sea to land transfer of radioactivity in the Ravenglass area.

For monitoring purposes, cows' milk is generally the most important foodstuff as grass is an efficient collector of atmospheric contaminants, cows graze significant areas of grass in the summer months and many of the more important radio-nuclides are rapidly passed from grass into milk. Milk is also a convenient product to sample regularly and analyse and is an important part of the diet, especially for young children and infants. In addition, cows graze a large area of pasture and therefore the monitoring of milk provides a method of carrying out surveillance of large areas. For most analyses of milk, weekly or monthly collections are combined (bulked) to provide four quarterly samples for analysis each year, although some analyses may be carried out more frequently, such as weekly iodine-131 analysis. Quarterly bulking of some samples is carried out for analysis of tritium and C-14 and annually for caesium ratios. The frequency of analysis of other foodstuffs is generally annual. This allows for a wide range of sample types to be collected throughout the year. Samples are collected from locations as close to the sites as practicable as these are usually the most sensitive to the effects of disposals.

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. Other monitoring is undertaken and 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 seafoods.

5.5.3.3. Reporting of results

The Environment Agency and the Food Standards Agency results from the monitoring programmes are published in annual reports. Prior to 2003 these were separate report series - 'Radioactivity in the Environment' and 'Radioactivity in Food and the Environment' for the Environment Agency and the Food Standards Agency respectively. From 2003 onwards joint reports have been produced by the two Agencies the latest published report is for the 2008 data. The joint reporting also incorporates monitoring undertaken in Scotland by the Scottish Environment Protection Agency (SEPA) (including that in South West Scotland assessing the impact of Sellafield) and information from the Nuclear Installations Inspectorate on direct radiation dose rate results.

The results from both the air and rainwater and public drinking water sources monitoring are also supplied to DECC and forwarded to the European Commission to the REM database. Also the Food Standards Agency supply the European Commission's DG Joint Research Centre (REM database) with milk and mixed diet data.

5.5.4 Scottish Environment Protection Agency Monitoring

Complementary monitoring in relation to Sellafield discharges is undertaken in Scotland by the Scottish Environment Protection Agency. This was not included in the verification.

6 VERIFICATION ACTIVITIES – RADIOACTIVE DISCHARGES

For better reading the description of the installations leading to radioactive discharges that were visited during the verification in 2004 and in 2010 as well as the results of the 2004 verification are given in Appendix 3 (full text of chapters 6 and 7 of the Technical Report UK 04/1).

Preamble: In the following the individual relevant results and conclusions of the 2004 verification are *given as citation (framed). The remarks to the recommendations as supplied by the Environment Agency ('Response October 2005') and by Sellafield Limited in 2010 ('Current Position') are given as well as citations. These are followed by the results of the 2010 re-verification.*

6.1 THORP – AQUEOUS DISCHARGES

6.1.1 Conclusion of 2004 verification (Main Findings 1.6, 1.8; Technical Report UK-04/1 chapter 7.1.2.3)

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.

6.1.2 Comments by UK

Environment Agency 'Response October 2005':

'It has been recommended to the Heads of Manufacturing that the details of the operator responsible for taking aqueous effluent samples is recorded. If accepted this requirement will be included in the next review of the liquid effluent management systems.

BNGSL have initiated a programme of work to produce a report by 31/01/06 defining the number and extent of engineering standards required to control the discharges of aqueous wastes. The calibration of accountancy sampling provisions will be addressed within one of the proposed standards.'

Sellafield Limited 'Current Position':

'All operators involved in the taking of samples are SQEP'd etc, and can generally be traced if need be. Sellafield Ltd considers that there will be no additional benefit from recording the operators' names separately, as they are already traceable through current systems.

Sellafield Ltd. does not intend to undertake any further proof testing of EARP concs sampling. This was originally done using lithium tracer testing during commissioning and nothing has changed to justify retesting. That testing showed the tanks are homogenised in four to five minutes. The control system is set up to mix for 20 minutes. The test was endorsed by Phil Stones, as the LECWP chair at the time. (See memorandum LEC(93)9 referring to test in evidence file).

Also attached in the evidence file is a Technical Specification A.0449_1, 'The characterisation & Categorisation of Aqueous-based liquid wastes This is a new standard approved and issued during 2009. Section 2.1.1 defines what measurements (e.g. sampling, discharge volume, pH, temperature and concentrations) are required for accountancy points. Section 2.1.5 refers to calibration. Company, national and Environment Agency's own standards (MCERTS – Monitoring Certification Scheme) for calibration are referenced in the Specification. In addition, accountancy point instrumentation (e.g. level indicator and flow meters) are subject to routine calibration and maintenance via the computerised maintenance management system (CMMS).'

6.1.3 2010 re-verification

The verification team received a detailed description of the management of liquid effluents at THORP and during the visit was accompanied by Sellafield Ltd. staff.

THORP discharges continuously, currently some 750 m^3/day, the released liquids having relatively low activity.

Liquid discharge control is mainly by gamma measurement (representing the highest category in the installation's safety mechanism). If the gamma monitoring system fails discharges are stopped. To reduce the risk of such failure two totally independent systems are operated in parallel, of different design to avoid the risk of a common cause failure. Two NaI(Tl) detectors are used for measurement, one looking 'down', one across the discharge line (at a 'knee' location). Proof tests for the devices have been developed; they are set at a high activity concentration level. The team was told that this would only occur only in case a filter fails.

At the time of the visit cleaning activities by washing were performed: some sludge in the line had increased the gamma radiation background.

During the on-site inspection the team visited the local cabinet with the 'Feed Pond Purge Gamma Monitor Equipment Cubicle' (key locked; containing a *Harwell 6000 Series Pond Purge Gamma Monitor 951032-1* with the electronics set at the determination of Cs-137 and Co-60; a 'EURO' frame with amplifier, single channel analyser, spectrum stabiliser, and scaler/timer). A trip level is set. The detectors (labelled 'SM') are scintillation detectors *Canberra Model G64SC2*.

In the control room the display was showing the data from the two gamma monitors.

The power supply for the gamma measuring equipment has a UPS with battery backup for 24 hrs, there is no diesel generator available. The team was explained that the preference is to 'put everything in a safe state rather than keep operating on diesel power'.

Waters from the Receipt and Storage and the Feed Pond purge are fed into an intermediate tank (ca. 1100 l) for continuous discharge to the sea. The team was told that usual flow rates are 24 m^3/hr, at the time of the visit it was 30 m^3/hr.

The team noted a proportional sampler at the Effluent Accountancy Points, working in vertical position: sample point 2275 (with markings in yellow colour, two 2 litre samples, one left as spare sample at place; yellow label including date, time, name of sampler) and sample point 2276 ('B570 Feed Pond', red markings, 1 litre sample for non-radiological analysis such as pH etc., red label with date, time, 'sampled by' and destination). Both samples are transferred to Analytical Services. Sampling is started manually. The labels (yellow and red) are prepared beforehand. Before sampling the tank is stirred for some 1 ½ minutes.

Sellafield Health Physics Dept. monitors all action. The name of the sampler is also noted on the daily shift log which is kept at the place, thus an audit trail with regard to sampling exists.

Together with the sample the change of custody form goes to the lab (e.g. alpha, beta, gamma measurement). The team was told that generally by early evening the results of the previous day discharge are available. (During the verification at the EAGLE data base the team received a detailed explanation of the new chain of custody procedure and associated forms.)

Also monthly bulk samples are taken for alpha spectrometry and for fission product analysis.

The verification team was informed that traceability of sampling and operator identity are established within the Sellafield system; additional identification by name is not necessary.

With regard to the calibration item the verification team was reasonably explained that the methods applied lead to satisfactory results. At the THORP C-14 removal facility proof tests are done at least annually.

The recommendations of 2004 have been reasonably taken up. The re-verification does not give rise to remarks.

The recommendations issued at the verification in 2004 are no longer pertinent.

6.2 THORP – GASEOUS DISCHARGES (MAIN STACK)

6.2.1 Conclusion of 2004 verification (Technical Report UK-04/1 chapter 7.2.2.)

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.

6.2.2 2010 re-verification

The verification team received a presentation and a detailed explanation of the THORP aerial effluent management through the stack (effective height 92.5 m). Altogether there are five sampled and monitored air streams to the stack (Dissolver Off Gas, Vessel Vent, C3 and C5 Glovebox). The Sellafield MOX Plant air streams connect into the THORP stack after all sampling and monitoring equipment as they are managed within SMP.

Sampling and sample analysis is performed for calculation of accountancy discharges, whereas monitoring on the one side provides real time information on aerial discharges and on the other side is used for generation of alerts in real time. Sampling with subsequent sample analysis is also seen as being more accurate. Except for Kr-85 monitoring which is used for statutory accountancy purposes. The Sellafield MOx plant (SMP) with its two gaseous discharge ducts - C3 and C5 - uses the THORP stack but has separate accountancy.

During the visit the team was shown the various sampling and monitoring devices. The team was explained that for the Dissolver Off Gas channel (DOG) no beta activity determination was ever commissioned because the system became swamped by Kr-85. With regard to Ru-106 monitoring this radionuclide never was detected; thus the Ru-106 monitor was shut down and the Ruthenium sampler was shifted (will be removed); this approach was approved by the Environment Agency (2009).

The systems are daily surveyed: filter cards are replaced at 15:00 for an initial reading (after 6 hours decay a second reading, after 24 hours another reading is performed). New filter cards are installed and all used filters are transferred in bulk to the laboratory on a weekly basis. The team was told that the filter card system has a pressure control device: damage of a filter leads to an alarm being generated in the control room.

The calibration of the Kr-85 monitors is done by personnel from Babcock Nuclear, based at THORP. They also perform the required proof tests. The other monitors are calibrated and the devices are regularly periodically proof tested and maintained (min 1/year, max 1/month)

Monitors are installed on all approved places methodology streams, but the data are not taken in consideration for the accountancy discharge value.

All Alpha/Beta Monitors are duplicate systems. The team was shown the devices in one of the rooms. There was no access made into the main windshield of the Stack (entering would have needed an additional permit for access). Also the room containing the Kr-85 monitor (installed only in one room) was not visited (would have needed oxygen monitor to enter).

The team was shown that for ease and correctness of identification the samples have the same colour code as the respective sampler.

In the sampler room all cubicles containing the devices are key locked (the only keyholder being the Health Physics personnel). This is to ensure that no access to devices can take place without consent.

For Dissolver Off Gas (DOG) the team noted that the flow meters (using pressure difference) are duplicate in the cubicle, with periodic maintenance. The monitor was calibrated when put in place and has a minimum yearly maintenance including flow rate calibration. All data including for the temperature probes (for temperature compensated flow measurement) are logged in an electronic system.

With regard to the DOG bubble sampler for H-3 sampling the team noted that two furnaces are available for HT: one on duty and one on standby. Sample change is each Friday morning; ½ goes to the lab, ½ is kept on site as reserve. For DOG I-129 determination a *Maypack* sampler (using Ag zeolithe) is used with sample change Friday afternoon.

For the particulate sampler (samples are taken and counted daily and after 6 days), each filter is moved individually, dated and timed. A digital flow rate display is available.

The team was shown methods used to improve temperature management for the gas flow system, such as applying covers around the piping.

With regard to the DOG duplicate alpha monitor the team was explained its functioning: a filter roll is advancing the filter material by 10 mm/hr, thus allowing four months of operation before filter change. All relevant data are alarmed to the control room (such as filter failure, high and low flow, etc.).

With regard to a DOG beta monitor the verification team was told that such a device was not commissioned (never went on line), due to the influence of Kr-85 disturbing any such measurement.

The DOG I-131 monitor is from *Berthold Analytik, model BAI9103*, working with an Ag Zeolithe canister. The device is used for plant control and efficiency checked in proof testing using a radioactive source. The device is replaced if necessary.

Other devices in the visited room were room monitors and portable monitors. The verification team witnessed a change of (the bar coded) filter cards by Health Physics personnel.

The verification does not give rise to remarks.

6.3 SMP – GASEOUS DISCHARGES

6.3.1 Conclusion of 2004 verification (Main Findings 1.5, Technical Report UK-04/1 chapter 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.

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.

6.3.2 2010 re-verification

SMP – gaseous discharges – was not touched during the verification in 2010. With regard to the 'approved places' methodology the 2010 verification is described in Chapter 6.5.

6.4 EARP AND SETP – AQUEOUS DISCHARGES

6.4.1 EARP – Conclusion of 2004 verification (Main Findings 1.6 and 1.7, Technical Report UK-04/1 chapter 7.4.2.3.)

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.

6.4.2 EARP – Comments by UK

Environment Agency 'Response October 2005':

'Multiple accountancy sampling points are only available at EARP and SETP. The sampling points at SETP are colour co-ordinated and locked to reduce the potential for human error during sampling operations.

The Liquid Effluent Control Working Party will consider the status of EARP sample points with regard to this recommendation and provide a plan for improvement by 31/01/06.'

Sellafield Limited 'Current Position':

'Sellafield Ltd has completed an improvement programme in this area. In order to address security arrangements and in particular T-059 sampling cabinet (referred to in observations), reference is made to, and evidence provided for, the EARP operations Bulk Sentencing Sampling Cabinet T-059 Compact Operating Instruction EARP/COI/19P, issued October 2008 (see evidence folder). The document clearly describes in Operation 2 (taking a sample), step 2.30 and 2.31, illustrating the mode of operation for labelling. This matter is further discussed in Appendix 1 'Sampling Procedure'.

Further evidence of security arrangements on plant is described in LAEMG Operator Instruction SETP/OI/54 issued September 2009, i.e. 'Operation Of The Sea Tank Proportional Samplers' (see evidence folder). Labelling is reflected in Appendix 6 under 'Sampling Procedure'. It should be noted that there is an operating instruction in place for all sampling operations. An example of an indicative audit applying to liquid sampling in the EARP area is also enclosed in the evidence file. Part 3 (specific items) in particular refers to comments describing the labelling procedure.'

6.4.3 SETP – Conclusion of 2004 verification (Main Findings 1.6, Technical Report UK-04/1 chapter 7.7.2.)

See also chapter 8.2 (similar text for THORP).

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.

6.4.4 SETP – Comments by UK

Environment Agency 'Response October 2005':

'It has been recommended to the Heads of Manufacturing that the details of the operator responsible for taking aqueous effluent samples is recorded. If accepted this requirement will be included in the next review of the liquid effluent management systems.'

Sellafield Limited 'Current Position':

'All operators involved in the taking of samples are SQEP'd etc, and can generally be traced if need be. Sellafield Ltd considers that there will be no additional benefit from recording the operators' names separately, as they are already traceable through current systems.'

6.4.5 EARP and SETP – 2010 re-verification

Before visiting the plants the verification team received a detailed explanation of the procedures applied at the Enhanced Actinide Removal Plant (EARP) and the Segregated Effluent Treatment Plant (SETP). EARP was built with regard to treatment of high risk low activity effluent from reprocessing operations. Bulk wastes of various origins (in particular from Magnox and Thorp reprocessing, and the Solvent Treatment Plant – STP, and concentrates (the Floc Retrieval Plant – FRP – and historic wastes from decay storage arrive at EARP. Originally the plant was designed to remove actinides from liquors prior to discharge to the sea through co-precipitation with iron. The original concentrates treatment process has been more recently enhanced to remove technetium from Medium Active Concentrates (MAC) using Tetraphenylphosphoniumbromide (TPB), in particular for historic waste from ~ 2004-2005. Suspension resulting from the treatment is ultra-filtered to separate the (solid) 'floc' from the less active liquor. Originally the ultra-filter was made up of graphite tubes with a ZrO_2 layer or alternatively in ceramic 'logs' with channels; Sintered stainless steel tubes now with a ZrO_2 layer are now the preferred ultrafilter with earlier filters being phased out over time. Floc is sent to the Waste Packaging and Encapsulation Plant, whereas liquids are fed to a sea tanks from where they are piped to the Break Pressure Tank (BPT) for discharge to the Irish Sea.

EARP concentrates works in batches because this allows optimised conditions (e.g. with regard to pH) to efficiently treat the material (compared to a continuous, mixed operation for bulks treatment). For actinides 99.9 to 99.99% are removed in this process. The continuous bulks process uses two sea tanks, one of them always available for filling, the other one for sentencing (analysis for discharge decision and balancing purposes) and discharge. As a batch process the concentrates only requires a single sea tank which is taken 'offline' for sentencing and discharge. The team was told that the liquid to be sampled is very clean thus proportional sampling does not give problems with fouling. Bulk samples of 2 ½ l in 'Winchester' type bottles are taken manually in a glove box. Higher activity concentrates samples of 150 ml are taken in 'subaseal' plastic bottles using remote tongs rather than gloves. Sample analysis results are reported to the shift coordinator for checking against the liquid effluent monitoring system. When authorisation is given the operator starts the discharge sequence.

SETP receives high volume, low risk, low active effluents from site operations. There are multiple donors from all over the site, e.g. cleaners' sinks, bund sumps etc. Main volumetric feeds stem from Magnox and Thorp. Acid and alkaline streams are kept separate to avoid volatile substances producing aerial discharges. Liquids resulting from the treatment are led to one of three tanks of 2600 m^3 each ('sea' or 'sentencing' tanks A, B and C). In the three sea tank filling lines proportional samplers are installed. For sampling the flow is split several times to allow a small flow to the respective 1.9 m^3 sample tank for sample collection, the large portion going to the respective sea tank; all this is software controlled. A display is available allowing checks of proportionality etc. to decide if the sample is representative. For discharge to the Irish Sea the liquid is pumped to BPT.

EARP and SETP discharge on batch basis. Discharge from BPT is twice per day within the tidal windows. Tidal tables are available showing times in GMT (Greenwich Mean Time) and BST (British Summer Time).

With regard to the discharges to sea the verification team was informed that two of the three sea lines (sealines 2 and 3) are in current use, Sea Lines 1 and 2 having been installed in the 1950ies, and Sea Line 3 in the late 1970ies. Sea Line 1 now is decommissioned (its removal is discussed as being a potential source of 'beach particles' – see Chapter 9.6), Sea Line 2 has a small diameter and Sea line 3 a large one. Laundry discharges usually go directly to BPT. Currently a re-routing of laundry discharges to Sea Line 2 is considered, laundry being a potential source of material that may block filters e.g. by lint.

During the visit of EARP the verification team received a demonstration of sampling (permeate low active sample cabinet T-059). Before sampling the liquid is sparged. Sampling takes place in a glove box using a sampling cabinet and a special intermediate sample container; the two parts are colour coded (left side red for Sea tank V-024 N1, right side blue for Sea tank V-024 N2). The demonstration took place on the blue side. The same colour codes are used on the switches to open the sampling valve to the intermediary container inside the cabinet; the valve to the sample receptacle is opened manually. Moving the sample out of the cabinet has to be done horizontally, which gives a risk of spillage if the bottle is not well closed. Horizontal alignment is necessary because currently the glove box entering mechanism only allows for the special intermediate container. During the sampling process another staff member performs wipe tests at the gloves using a contamination monitor for immediate measurement. The sampling form 'EARP Sea tank sample' is filled in; signing is not necessary because a prepared change of custody form is used. Subsequently in a second cabinet (low active receipt tank cabinet T-089) in a further step the sample bottle is removed from the intermediary container; this is an additional necessity, only there it is possible to switch from 'horizontal' to 'vertical'. Finally, the filled-in label (prepared beforehand) is checked and attached to the sample bottle. (Since this was only a demonstration, during the visit the 'sample' was returned to the system.

The team was told that this sampling system will be modified: only one sampling glove box will be necessary.

For the SETP Sea Tanks (tank A red, B black, C green; and sample lines A, B, C) sampling is done for accountancy with three sample cabinets available; these are not colour coded but all information is printed on the accompanying sheet with the labels; the label is peeled off and attached on the sample bottle. The sample sheet is signed off by the sampling staff member. The verification team was shown the appropriate chain of custody form. The 2004 recommendation of recording the name of the sampler has been taken up in the form number IS/58/08. The team witnessed a sampling from tank A (via the respective sample tank) and noted that the valves in the sampling boxes are key locked with separate keys. After stirring samples of 1 l and of 125 ml are taken; the first sample is discarded.

During sampling continuously contamination checks are performed by a second staff member, e.g. of clothes. The team was told that formerly there was a colour coding on the printouts matching the tank colours, however this was seen to be too expensive with regard to the positive effects associated. Generally, valves and pipes are well labelled. The sampling sheet is well designed. The 'final sample' in a 1 l screw cap Winchester type bottle is the accountancy sample and has a change of custody form (introduced in March 2010); the 125 ml preliminary sample does not. The team was told that a real discharge to BPT is done only after several steps of control.

With regard to the details of a discharge one of the LAEMG shift coordinators explained the procedure and showed the according steps on a computer screen. After receipt of an SETP sea tank discharge authorisation request the according form is checked (all necessary data are available within the IT network) and compared with the sample result report, sample number etc. Formerly also fax has been used for data transmission but the fax quality made mix-ups possible; thus this procedure has been abandoned. Checks are performed with regard to U content, pH, alpha, beta (daily, weekly) guideline. In case a query is necessary an email is sent to the laboratory. The database for LEMS (Liquid Effluent Management System) contains the discharge authorisation ceilings for alpha and beta (daily and weekly). There also exist monthly ceilings (well below regulatory limits). A visual indication (input number in red) is given if a number above a ceiling is input. For each discharge weekly and monthly limits are checked with a view to avoid any problems for future discharges. The tidal window for discharge is marked on the form. The signature of the responsible is foreseen on the form but not linked to a name in clear writing (there exists no list with name and signature), however such a link is possible via the date/time given on the form.

Generally, information from the laboratory about activity concentrations arrives without delays, taking into account that three sea tanks are available and that discharges can be done only during a tidal window. If information has to be passed on to the next shift this is done within the routine shift change meeting.

For the Break Pressure Tank (BPT) gamma monitors are installed at the inlet and also at the outlet. Emptying is by pumping is by gravity. The team was informed that in case of gamma measurement 'high' valves close and the pumps have to work against a closed valve. However this is not seen as a problem since ample time is available; the shift coordinators would be involved (as well as the Health Physics department) for finding the reason and for decision.

Alarm limits for gamma measurement are set at 200 microSv/h. The team received an on line demonstration of the system with a set of data on the display, for example one minute measurement intervals. Averaging for 24 minutes is possible for storage in a data base. The system is a DOS application and gives the impression of not being very user friendly (e.g. using 'U' for 'µ' on the display).

With regard to the recommendation from 2004 concerning EARP (1st part) the verification team was informed that traceability of sampling and operator identity are established within the Sellafield system; additional identification by name is not necessary.

With regard to the recommendation from 2004 concerning EARP (2nd part) the verification team was shown that the 2004 recommendation has been taken up.

With regard to the 2004 recommendations for EARP and SETP the verification team was reasonably explained that security issues have been addressed in the procedures and the traceability of responsibility within the chain of custody is given.

With regard to the recommendation from 2004 concerning SETP the verification team was informed that traceability of sampling and operator identity are established within the Sellafield system; additional identification by name is not necessary. Thus, the recommendation from 2004 can be seen as implemented.

The recommendations issued at the verification in 2004 are no longer pertinent.

The verification team encourages the planned change of the sampling system for EARP that would avoid the additional risks of contamination.

With regard to the discharge checking procedure the verification team suggests having a list with names and signatures available to allow easy linking and thus quick relating in case of necessity (e.g. after several months or years).

6.5 DATA COLLECTION OF AERIAL AND LIQUID DISCHARGES; ESTIMATION OF GASEOUS DISCHARGES FROM SELLAFIELD ('APPROVED PLACES' METHODOLOGY)

6.5.1 Results of 2004 verification (2004 Main Findings1.5. and 3.6.; Technical Report Chapters 7.3.2., 10.1.13. and 10.1.14.)

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.

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.

6.5.2 Comments by UK

First recommendation
Environment Agency 'Response October 2005':

'BNFL commissioned a review of the 'Approved places methodology' as part of its aerial R&T programme for 2003/04. The review was carried out by Westlakes Scientific Consulting Ltd (Investigating possible improvements - T J Taylor (Doc. No. 030133/01) and issue 1 of the report was published on July 2005. See copy in evidence file. Recommendations for improvement will be considered and implemented where appropriate.

A further review of the 'Approved places methodology' has been initiated in association with the Environment Agency. Following a review meeting carried out with the Environment Agency options for further improvement are under consideration. These include: extending the accountancy at source for the 'miscellaneous' sources where practicable. Implementation of the recommendations from the Westlakes Report.'

Sellafield Limited 'Current Position':

'As a result of the Sellafield Ltd response submitted to Environment Agency in October 2005, the Environment Agency wrote to Sellafield Ltd in December 2005 (ref. SEL/05/115/O) requesting implementation of the recommended improvements (see evidence folder).

A second review was then carried out by Westlakes Scientific Consulting Ltd: Updated Dispersion Factors etc by R Hill - issue 1, published in July 2006. (Copy Document No. 050272/01in evidence file).

The updated methodology (referred to above) was implemented based on this report with effect from August 2006. This was effected in agreement with the Environment Agency letter ref. EA/06/6919/05, dated December 2006 (see evidence file).

In addition to meeting all requirements of the Authorisation, Sellafield Ltd has further commissioned a review of its approved place methodology and implemented the recommendations (Ref. SSEM/2006/12, dated November 2006, copy in evidence file).

Sellafield Ltd therefore considers that he efficacy of the current methodology for reporting discharges from miscellaneous and other outlets has been fully reviewed in conjunction with the Environment Agency, with agreed improvements fully implemented.'

Second recommendation
Environment Agency 'Response October 2005':

'An annual review of the overall programme of environmental monitoring is carried out in association with the Environment Agency as part of BNGSL's compliance with the current Compilation of Environment Agency Requirements (CEAR authorisation). Krypton-85 forms an integral part of this review. During the review, it was agreed that Kr-85 will form part of the future environmental monitoring programme.'

Sellafield Limited 'Current Position':

'The requirement to monitor environmental concentrations of Kr-85 was added to the Sellafield environmental monitoring programme effective from April 2006. This required fortnightly sampling and analysis at the Sellafield Met station which is located 200m off-site. In practice, implementation of routine monitoring commenced April 2007, due to difficulties in re-commissioning the analytical method. The method validation and quality assurance report is attached in the evidence file (Westlakes Report, document no. 070068/02).'

6.5.3 Results of 2010 verification

The verification team received a detailed explanation about the EAGLE (Environmental Analysis of Gaseous and Liquid Effluents) database, in particular about changes that have been or are to be implemented. EAGLE is the main tool for managing discharge data. There are some 15000 records to be registered each year; per year 270 reports have to be sent out. The process still uses the same Oracle data base as in 2004 plus MS Access tools at the end points. The user interfaces have changed considerably, in particular with regard to Quality Assurance. For example checking processes for the plants as 'data owners' have been introduced: the user himself can check his data directly in the data base in electronic form (formerly faxes had to be sent for manual input). Electronic management of data has been implemented in order to avoid human inputting errors. There still is a hard copy report sent to EA.

The main EAGLE entries are plant data, reference data (technique documents), sample results, permit information.

EAGLE also delivers the instructions for bulking samples (e.g. to form a monthly sample based on daily ones); these are checked by the plant and implemented by the laboratory.

The main EAGLE products are records (ready for audits, are not transmitted to EA), reports (are sent as hard copy and electronically to EA), trigger levels and limits, etc. For THORP still transmission by hard copy is used; the team was informed that this will be changed.

With regard to the internal data transfer to the data base Lotus Notes 7 is used: discharge data are electronically signed, transferred to EAGLE, and checked twice to authorize data for export and further transfer. In the beginning reactions by users such as 'never seen that before' were encountered. However, the tool allows users to look at discharge data in an easy way; also data retrieving by authorised persons is transferred to EAGLE.

With regard to the 'approved places methodology' the team was informed that since the last verification in 2004 new high volume air samplers (then 4, now 5) were installed, however not yet fully implemented. Dispersion factors have been recalculated to incorporate all sites / stacks. A technical document from 2008 reflects the work accomplished. Thus the 2004 recommendation can be seen as implemented.

The verification team was assured that the issues have been taken up and a review with regard to the 'Approved Places Methodology' has been carried out; Kr-85 monitoring was added to the site's environmental programme. Thus the respective recommendations have been taken up. However, the verification team noted that the site frequently undergoes significant changes, both, with regard to relevant nuclear activities as with regard to changes due to various construction projects.

> *The respective recommendations issued at the verification in 2004 are no longer pertinent. However, the team recommends regularly verifying if the conditions for the application of the 'Approved Places Methodology' are all still met.*
>
> *The verification team encourages the ongoing change in data transmission methods to electronic formats and procedures.*

7 VERIFICATION ACTIVITIES – ANALYTICAL SERVICES LABORATORY

For better reading the complete description of the installations leading to radioactive discharges that were visited during the verification in 2004 and in 2010 as well as the results of the 2004 verification are given in Appendix 4 (full text of chapter 8 of the Technical Report UK 04/1).

Preamble: In the following the individual relevant results and conclusions of the 2004 verification are given as citation (framed). The remarks to the recommendations as supplied by the Environment Agency ('Response October 2005') and by Sellafield Limited in 2010 ('Current Position') are given as well as citations. These are followed by the results of the 2010 re-verification.

7.1 SAMPLE PREPARATION

7.1.1 Conclusion of 2004 verification (Main Findings 2.3, Technical Report UK-04/1 chapter 8.3.2.)

> *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.*

7.1.2 Comments by UK

Environment Agency 'Response October 2005':

'Following a review of Analytical Services sample management procedures a draft Analytical Services Instruction has been produced – ASI/440/P – which details the procedures for the management of samples within AS laboratories. This will be issued following the standard documentation review procedures. Additional control of sample management is achieved through the use of the Analytical Services Procedure for information management – ASP5 (See evidence file).'

Sellafield Limited 'Current Position':

'The Analytical Services Instruction ASI/440/P was reviewed by the standard document review procedures and subsequently issued, copy in evidence file.

Internal sample management is controlled by ASI and SLIMS, this aspect is thoroughly audited internally and by UKAS as part of internal traceability.

Sample management prior to delivery to Analytical Services is controlled by operating plant customers. SSP 2.01.10 (Management of Discharge Records etc) included in evidence file along with Change of Custody Form SSF 2.01_01. Sellafield Ltd has implemented this form (see change of custody form briefing in evidence file), with the requirement that all samples will be submitted using the new form after 31 March 2010.'

7.1.3 2010 re-verification

The verification team was shown that the 2004 recommendation was dealt with and that adapted procedures were implemented.

The recommendation issued at the verification in 2004 is no longer pertinent.

7.2 GAMMA COUNTING LABORATORY

7.2.1 Conclusion of 2004 verification (Main Findings 2.4, Technical Report UK-04/1 chapter 8.3.3.)

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.

7.2.2 Comments by UK

Environment Agency 'Response October 2005':

'The use of detection limits in reporting radioactive discharges is currently under review as part of the European Commission Article 37 recommendation Consultation summary paper DEFR-6701. A workshop was carried out with attendance from DEFRA, Environment Agency, NDA and Operators. The recommendation from this workshop [Ref 3] was to utilise ½ the decision threshold (¼ current LOD) to better represent the Limit of Detection when reporting discharge results. The implication of this recommendation has not been fully considered and hence, ongoing discussions are taking place between stakeholders.'

Sellafield Limited 'Current Position':

'With respect to the reporting of discharges and the EC Article 37 Recommendation, the Environment Agency and Scottish Environment Protection Agency have published guidance on standardised reporting of radioactive discharges [Ref 4]. This guidance was developed jointly with the nuclear industry, including Sellafield Ltd. The guidance includes definitions of detection limit and decision threshold and these will also be incorporated into an Environment Agency MCERTS standard on the radio-analysis of waters. This MCERTS standard is also being developed jointly with the nuclear industry and analytical laboratories and has input from Sellafield Ltd. In anticipation of these new requirements for reporting Minimum Detectable Activity (MDA), Sellafield Ltd Analytical Services has commenced a staged implementation. The short term scope of MDA implementation has been defined and a staged implementation commenced. The first stage is complete and has included gamma spectrometry analysis of aerial discharge samples and Lagoon and Laundry liquid effluent samples, most of which are performed by the external contractor, VT Nuclear Laboratory, with a limited number performed onsite. However, this has required manual operator interaction in the on-site facility due to the current software limitations but is tolerated due to the small number of samples. Later stages will extend to other radiochemical methods, e.g. Tritium and Carbon 14. The longer term scope and programme of implementation, currently being developed, will include other liquid effluent samples, i.e. those analysed entirely on-site. The process will again be staged due to the requirement to ensure that customers, including the chemical and waste treatment plants, are supportive with no plant control concerns. There is also a need to develop MDA algorithms, to integrate them into the accredited analytical methods and to train operators. A proposal to replace the on-site facility gamma spectrometry system is currently awaiting NDA approval. If approval is given, it is expected that, allowing six months for the system build by the manufacturer, it will be in place and operational within 12 months. This will include the capability to routinely report MDAs or to report in A +/- B format. A risk to full implementation is the delay in placing the new contract for the external work package. The commercial process has been delayed by legal issues. The reporting of discharges is covered by recommendation 4.3. Recommendation 2.4 is associated with the reporting of analytical results from the relevant laboratory. This is being addressed by the transition to MDA reporting as described in the position statement.'

7.2.3 2010 re-verification

The recommendation of 2004 originally was referring to the treatment of measurement uncertainty, not of detection limits. However, there is a strong methodological link.

The verification team was informed that – triggered by the 2004 recommendation – in a staged approach newly developed guidance with regard to reporting of discharges is implemented (see Chapter 9.3).

The recommendation issued at the verification in 2004 is no longer pertinent.

7.3 QUALITY ASSURANCE IN THE GAMMA COUNTING LABORATORY – ITEM 1

7.3.1 Conclusion of 2004 verification (Main Findings 2.5, Technical Report UK-04/1 chapter 8.3.4.)

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 backgrounds and the risk of contamination in the laboratory.

7.3.2 Comments by UK

Environment Agency 'Response October 2005':

'There is a requirement to store samples within the laboratory for approximately one week to allow for the investigation of measurement anomalies and customer queries. A series of background checks carried out during October2005 determined that the location of the full sample trolley within the laboratory had no effect on the background measurements of the gamma detectors.

These tests will be repeated when all major plants are operational to confirm the above. The number of samples stored within the laboratory on a long-term basis is being reviewed, to establish whether an overall reduction in sample numbers stored is possible.'

Sellafield Limited 'Current Position':

'Sample management has been improved and routinely samples are not stored long term, background checks are performed regularly and no increases have been detected. It is considered that sample management practices have been reviewed and improvements implemented in line with the recommendation. See instruction ASI 440P and Procedure ASP 5 in evidence file.'

7.3.3 2010 re-verification

The verification team received an explanation how the procedures were improved taking into account the 2004 recommendation; it received copies of relevant documents.

The recommendation issued at the verification in 2004 is no longer pertinent.

7.4 QUALITY ASSURANCE IN THE GAMMA COUNTING LABORATORY – ITEM 2

7.4.1 Conclusion of 2004 verification (Main Findings 2.6 part 1, Technical Report UK-04/1 chapter 8.3.4.)

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.

7.4.2 Comments by UK

Environment Agency 'Response October 2005':

'BNGSL Analytical Services have implemented the following inter-laboratory proficiency-testing schedule for 2005/2006.

1. CONTEST – Laboratory Government Chemist – quarterly samples for HPLC, ISE and ICP-MS analysis.

2. Radionuclides in Water – Bundesamt für Strahlenschutz – TIMS, Alpha spectrometry, Gamma spectrometry and total alpha analysis.

3. Metals in 0.5% w/v Nitric acid – Aquacheck – ICP-MS analysis.

4. Environmental Comparison – National Physics Laboratory – Gamma spectrometry, Alpha spectrometry and liquid scintillation analysis.

5. SPIL-4 wastewater – Eurofins A/S – conductivity, pH, HPLC, ammonium and nitrogen analysis.

The schemes were chosen to ensure a broad range of analytical methods used within Analytical Services was covered.'

Sellafield Limited 'Current Position':

'An annual schedule is drawn up and monitored by the Quality Manager. Analytical Services Inter-comparison Schedule 2009/2010 attached in the evidence file. It is considered that the foregoing responses demonstrate that the laboratory regularly participates in inter lab proficiency tests.'

7.4.3 2010 re-verification

The verification team was informed that participation in inter-comparison tests to assure analytical quality has been implemented.

The recommendation issued at the verification in 2004 is no longer pertinent.

7.5 QUALITY ASSURANCE IN THE GAMMA COUNTING LABORATORY – ITEM 3

7.5.1 Conclusion of 2004 verification (Main Findings 2.6 part 2, Technical Report UK-04/1 chapter 8.3.4.)

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.

7.5.2 Comments by UK

Environment Agency 'Response October 2005':

'The Environment Agency has mechanisms in place to do this. Unfortunately the reporting of comparisons had been halted temporarily during 2003, due to resource issues. Since the verification visit the backlog of 2003 independent discharge sampling programme results has been provided to the operator. Results are now once again being provided on a quarterly basis to the operator.

In addition to providing the independent results, the Environment Agency arranged a review meeting in May 2005 to follow up on discrepancies and facilitate method improvements. Managerial and technical specialists from the operator, the independent contractor (the Health Protection Agency (formerly the National Radiological Protection Board)) and the Environment Agency were present, with both the Analytical Services Laboratory and the Geoffrey Schofield Laboratories being represented for the operator. Actions placed at the meeting will allow for the exchange of information and investigative work to be undertaken to better understand what leads to discrepancies and ensure the best analytical methods are being employed.'

Sellafield Limited 'Current Position':

'Comparison results continue to be shared with Sellafield Ltd and these are reviewed and any discrepancies discussed at a meeting with the independent contractor.

2009 Sellafield Sample Programme in evidence file. Also enclosed are radiological effluent comparison results.'

7.5.3 2010 re-verification

The verification team was assured that the reporting was halted only temporarily and has been fully resumed.

The recommendation issued at the verification in 2004 is no longer pertinent.

7.6 ANALYTICAL SERVICES LABORATORY VISIT OF 2010

The verification team received a specific presentation on the work of the laboratory and visited the premises that are located in the controlled area. From an organisational point of view the Analytical Services Laboratory belongs to the Infrastructure Directorate of Sellafield Ltd. Currently there are 220 full time equivalent employees including 98 analysts and 24 process support low level technicians. Because of the highly labour intensive processes all have Human Performance coaching or are themselves coach. Currently a reorganisation of the department is ongoing.

Tasks are analytical support for THORP (interface for site before going out to contractor for environmental analysis) and analysis (plant control; product quality; environmental monitoring; safety control and material accountancy). With regard to decommissioning work is seen not as routine task rather in form of studies. Part of the samples is analysed by Analytical Services, for other samples Analytical Services acts as "Intelligent Customer" for the plants requiring the analyses, by outsourcing. Further on the laboratory deals with 'finger print' analysis and with analysis of SIXEP sludge. Another task performed in the laboratory is bulking samples, i.e. preparing monthly samples for example from EARP discharges, using specified dilution parameters; the results of the analysis of such bulked samples is used in the EAGLE database. Altogether, the Analytical Services Laboratory handles some 100000 samples with some 300000 determinations per year.

In the laboratory 180 quality assured analytical methods (QAAM's) are applied; for all these control charts are prepared. Since 1991 the laboratory has UKAS accreditation according to ISO 17025 for 80 to 90% of the methods that are used; UKAS audits take place every year. The Sellafield site procedures plus the ISO17025 SOPs are used as Quality Manuals. For proficiency testing on advice of UKAS an annual schedule has been developed; participation in some 4-5 different ones annually, incl. European wide ones, is expected. These would also cover non-radiological tasks. The team was told that the staff members responsible for QM try to find as many as possible that are suited. E.g. for ICP-MS the Analytical Services Laboratory participates in round-robins. 'Failing' in such exercises is not necessarily seen negative, but as a way to improve the applied methods.

The Analytical Services Laboratory operates its own standards laboratory (e.g. for balances) and follows external and internal audit programmes.

The team visited the dispensary where (effluent) samples arrive and are stored in a locked facility (sample integrity is very important). The sample flasks have a description containing number, code, date, time, a unique identification, any additional information such as 'stabilized' etc. The samples are booked in, followed by 'paper work' (with regard to the change of custody form), including signing. The 'new' change of custody form (introduced in beginning of 2010) has been very well accepted. If needed a copy is passed on to the customer, signed as 'original'. The form contains also information on the sample carrier, sample received by (all with name, signature and date), plus a part for remarks (including signature).

Data are entered into Sellafield’s Laboratory Information System (SLIMS) as soon as possible. SLIMS prints out the Laboratory Sample Number (LSN), time and date when received, plus date and time when sampled and originator information. The LSN is attached on the form as label ("booked in").

(Data are filled in by the customer; the label is produced by the laboratory.) Each form has a serial number for easy identification.

In case data for SLIMS are missing a clarification by liaison officers is foreseen, laboratory staff does not have to involve themselves in such tasks, they can 'concentrate on work'. In the case 'conditions of acceptance are not met' the information is recorded, the liaison officer is informed and the sample is put aside. An event reporting system is in place. With regard to laboratory information management the team was informed that the site operator is in the process of developing "SLIMS-2". Currently paperwork is used as backup.

The team was told that after analysis retention times for samples as stipulated by EA are kept; then the sample is disposed of.

During the visit the team was explained and shown preparation of samples for dispatch to Westlakes (Babcock International Group – The Environmental Lab 'GSL') and other laboratories. Generally, these are witnessed samples, packaged in chemical hoods. Quick alpha/beta checks on the (e.g. filter) material are performed as basic screening.

For the identification of particles the sampling tray is taken, the medium is reassembled in a way that the particle is in the centre, then gamma spectrometry is performed.

The team visited the Liquid Effluent (radiochemical) Laboratory (key locked when not used) where samples of liquid effluent streams are prepared. It received an explanation of sample stabilisation (various methods are applied for high salt content, e.g. using HNO_3 or HF) and its impact on the 'dilution factor' for bulking samples. Information on bulking instructions are checked and proportional bulks according to the procedure given on an *EXCEL* sheet (copy pasted from the original data sheet, received via the liaison team) are prepared. (The team received a copy of a monthly bulking instruction and thus could follow the procedure.) The verification team noted that the laboratory premises are quite old, in particular the ceiling was not in good shape. However, it was informed that a laboratory refurbishment project was ongoing.

The verification team noted manually written control charts (operator guidance what to do in case of deviations); regular checks are performed by the team leader. The overall impression was that the laboratory is very orderly and has very well organised working places (obviously supported by very personal encouraging material).

With regard to the implementation of the 2004 recommendation on reporting of activity levels lower than detection limits the team saw a prototype MDA reporting document ('Calculation procedure for Sr-89, Sr-90').

For checking reporting quality the verification team performed a tracing and chose the LSN1295776 bulked sample (May 2010). The value for Am-241 shown in the laboratory sheet was in total agreement with the value in SLIMS.

As an example for used analytical method the radiochemical determination of Am-241 in the Enhanced Actinide Removal Plant Effluents (permeates) was described. It is based on the document Analytical Services QAAM 587 Issue 5 03/2010, uses Am-243 as tracer, LaF3 coprecipitation an intermediate step with HBO_3 and $LaOH_3$ coprecipitation. Measurement is with low energy gamma spectrometry.

For gamma spectrometry the laboratory uses equipment from *Canberra*, *Ortec* and *Nuclear Data* (*ND*) with HPGe (including BeGe and LEGe types) detectors of > ca 50% relative efficiency and approximately 1.9 keV resolution, some cooled with liquid nitrogen, some electrically (*Ortec Xcooler II*). Shields are commercial round respectively with Pb rings or with Pb swallow tail bricks (10 cm Pb). Signal processing is done with a *Canberra DSA2000* device and *Ortec* and *Canberra* NIM modules. Sample holders are used for centering samples on the detector end caps (also for Be window type) working optically with concentric rings in different colours. For spectrum analysis still an old Nuclear Data analysis system is used; the team was informed that changing to Canberra Genie is in preparation.

For the detectors the description table was available (associated QAAM, range, matrices).

Checks for energy and calibration are performed every day (using a certified Am-241 source), background measurements every night. Calibration checks are marked on the respective shield with labels with signature. The team noted a label with calibration date 'Oct 2005' and date for next calibration 'next due Oct 2009; the team was explained that the delay was due to the expected receipt of a new gamma spectrometry system, which however is delayed – separate calibration of an old system would not be reasonable.

Calibration standards used are from *Amersham* (e.g. Am-241 Std 992 of 3 June 2006, AMZ440/S3/21/29 and Co-57 Std 974 of 2 June 2006, CTZ64/S5/18/63), calibrated distances are 10 cm and 20 cm; one system is calibrated with *Canberra ISOCS*.

In addition to the permanently installed high resolution systems the laboratory has one mobile, battery operated *Ortec TSPEC* device available. A Canberra sample changer was used, however put out of operation due to problems.

The team also noted a NaI(Tl) low resolution gamma system with sample changer (*Gemini Technology*), mostly for plant control samples.

For (gross) alpha/beta measurement various devices are available, such as a *TriCarb 3100 TR* and a *Packard 2200CA* liquid scintillation counter, a *Lab Impex B5020* beta counter with sample changer, three *Tennelec Series II Automatic Planchet Counting Systems*, a *Tennelec LB5500* and a *LB5050* device, and two *Lab Impex A5400/112* systems.

For alpha spectrometry the system in use consists of a *Canberra Alpha Analyst* device with 12 chambers and *Canberra Genie 2000 Alpha Analyst* software. A new system is installed using three *Ortec Octète plus* modules (with 450 mm^2 detectors) and *AlphaVision-32* software; at the time of the visit calibrations were performed.

Furthermore the laboratory operates a new ICP-MS (*NU Instruments*) and two ICP-OES devices (old).

Several PCs are available for data analysis; one PC is used as interface to SLIMS.

All instruments have service contracts based on 'call out'.

The verification does not give rise to remarks.

8 VERIFICATION ACTIVITIES - ENVIRONMENTAL MONITORING PROGRAMMES

With regard to the monitoring of environmental radioactivity due to organisational reasons the verification concentrated on on-site tasks. Off-site environmental monitoring was not verified, as was also not the laboratory analysing environmental samples.

8.1 SELLAFIELD MONITORING PROGRAMME

Due to time constraints and bad weather conditions the verification team concentrated on the installations near the North gate and near the bridge over Calder River.

Near the North gate a fenced area of ca. 5 m x 5 m is used for grass and soil sampling; nearby two HiVol air samplers and a small precipitation sampler are set up. The visited borehole for groundwater sampling was in close vicinity.

8.1.1 Onsite dose rate and aerosol sampling

8.1.1.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.1.)

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.

8.1.1.2. Results of 2010 verification

During the verification visit in 2010 the issue of including information from those devices in the site impact evaluation was not discussed.

8.1.2 Site perimeter dose monitoring

8.1.2.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.2.)

The team verified that one of the TLD monitoring stations located on the site perimeter (West ring 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.

8.1.2.2. Results of 2010 verification

In 2010 the team visited a different station, near the bridge over Calder River (close to the surface water sampling station). The dosimeter was inside a small plastic bottle which was mounted on a lamp post, some 1.5 m above ground.

The verification does not give rise to remarks.

8.1.3 High volume air sampling

8.1.3.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.3.)

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.

8.1.3.2. Results of 2010 verification

In 2010 there two such HiVol samplers were installed at the site near the North Gate. Both samplers (Australian produce) use glass fibre filters (8"x10"); flow rate is 67-70 m3/h. The verification team noted a flow rate calibration check label dating from 17.8.2010. The team was informed that one of the devices – belonging to the regulatory system – is used with generally monthly, sometimes biweekly filter changes, the other one with sampling times of one week. The latter device belongs to the 'pond investigation project' and is moved to other locations when needed.

The verification does not give rise to remarks.

8.1.4 Grass and soil sampling

8.1.4.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.4.)

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.

8.1.4.2. Results of 2010 verification

In 2010 additional information with regard to this sampling was given during the verification of the location. For soil samples a 4" diameter corer is used and 5 cm deep samples are taken at several points. Before sampling vegetation is cut off at 1 cm.

Grass is sampled in the 2nd, 3rd and 4th quarter of a year, leaving out the winter season, by manually cutting the vegetation in the whole fenced in area, 1 cm above soil. All cut material is taken except woody parts.

The verification does not give rise to remarks.

8.1.5 Rainwater sampling

8.1.5.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.5.)

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.

8.1.5.2. Results of 2010 verification

For collection of deposition / precipitation at the corners of the square area near the North Gate two samplers with a diameter of ca. 15 cm each are used. The sample containers are changed twice per month. Dark bottles are used to minimize growth of algae in the sample containers (this was encouraged at the verification visit in 2004). Carrier solution is applied. No temperature control is installed. In former years snowfall in the Sellafield area has been minor, thus no measures to avoid sample losses were necessary. However, locals say there has been quite a lot of snow lately during winter. Therefore, now the verification team sees a risk of build-up of a snow cover on top of the devices in winter. Blowing off of snow by wind would lead to a considerable loss of sample. Heating of the samplers when temperatures fall below 5°C would avoid such an effect by melting the snow and would also avoid freezing of the sample.

The verification team recommends heating the device in winter to some 5°C in order to allow melting any snow covering the sampling device.

8.1.6 Contaminated land flow sampling; Onsite groundwater sampling

8.1.6.1. Results of 2004 verification - Contaminated land flow (2004 Technical Report Chapter 10.1.6.)

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.

8.1.6.2. Results of 2004 verification - Onsite groundwater (2004 Technical Report Chapter 10.1.7.)

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.

8.1.6.3. Results of 2010 verification

In 2010 the verification of land flow issues was combined with the one for ground water sampling.

The verification team was given a presentation about the groundwater monitoring requirements and how these requirements are met by Sellafield Ltd. Within the operator responsibility lies with the Land Quality Group. Annually, groundwater sampling is scheduled. E.g. in 2008 145 boreholes and 226 piezometers were used, with altogether some 1300 samples collected, covering the site itself and the area towards NW of the site and SW towards the Irish Sea. At 132 piezometers samples are obtained by bailing, at 94 piezometers via micro-purge sampling. For some boreholes there are some quality issues such as a potential of surface water flooding into the piezometers, or with regard to labelling. According work plans to improve borehole quality are to be established.

During the re-verification the verification team received a successful demonstration of the micro-purge sampling method, in connection with groundwater sampling at borehole site BH 6960 P1 close to the north gate. The site is key locked and walled to avoid surface water inflow. Using the micropurge device (*QED*, *Well Wizard* as control unit, electric power supply by the car battery) measurements of borehole depth, pH, Eh, conductivity, turbidity, dissolved oxygen, temperature, etc.; are performed. When the measured values are stable a water sample is pumped using compressed air to push the water; filtering is done with 0.45 µm disposable filters. The sampling procedure was readily available in the car; the sample description sheet was filled in at place. Since at the time of the visit there was a heavy rain fall and the papers were not protected e.g. by plastic sheets the team noted a risk that the documents used could be mutilated and made illegible by the water.

With regard to the second sampling method the team was explained that a bail of 1 l volume on a cord is used applying a 'ping pong ball' valve.

> *The verification team encourages establishing and implementing plans to improve borehole quality and thus quality of the data used for the safety assessment. With regard to documents used at sampling it suggests protecting all documents that are taken outside the car by foil welding or similar in order to avoid mutilation by rain water.*

8.1.7 Offsite river water sampling

8.1.7.1. Results of 2004 verification (2004 Technical Report Chapter 10.1.9.)

> 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.*

8.1.8 Comments by UK

Environment Agency 'Response October 2005':

'A review of sampling procedures / instructions in relation to the above is currently in progress. Improvements identified from this will be incorporated into the sampling procedures / instructions from 01-01-06. It should also be noted that it is intended to install a continuous automatic water sampling system for the River Calder. Formal Environment Agency approval of the operation of these systems will be required.'

Sellafield Limited 'Current Position':

'Automatic river water samplers (*Aqua S2-RK32*) have been installed on the river Calder, both upstream of site and on site above the limit of the tidal range. These are operated to take samples at fixed time intervals such that approximately 30 litres is sampled each month. The samplers have been in operation since early in 2006. The move to automatic sampling system negates the requirement to describe river conditions. Instruction EMA2.1/OI/02 refers, in the evidence file. The monitoring team's log book is used to record the sampler's identity. This allows a cross check against training records or facilitates any investigation, should there be a problem with the sample. An example of log book and change of custody form are attached in the evidence file.

The move to automatic sampling was discussed at quarterly meetings with Environment Agency, minutes of a meeting and progress report are attached in the evidence file. Regarding Environment

Agency approval, the CEAR requirement was not updated until April 2009. The new system replaces grab samples.'

8.1.8.1. Results of 2010 verification

In 2010 off-site installations for environmental radioactivity monitoring were not included in the programme of the visit. However, in replacement of the 'upstream' Calder River sampling site the team visited the new 'downstream' sampling site which is actually located within the general premises of the installation. The team was informed that both sites are equipped with the same type of devices.

An *Aquamatic Waste Water Sampler* (Manchester, England) installed some metres above the river surface is used to retrieve water using a pipe in the river and a soft hose. Sample collection is time proportional, there is no link to the water flow in the river. After purging every 80 minutes some 100 ml water sample are sucked in and deposed in a container of some 10 litres. The sampler and the sample container are mounted in a small cabin, the sample being cooled in a refrigerator (5°C, key locked). At the end of each month the complete sample (e.g. 30 litres) is kept refrigerated and transferred to the analysis laboratory. Additionally, grab river water samples are taken for non-radiological purposes.

The verification team noted a calibration label (29.07.2010; Sam Sys as contractor; based in Manchester), the firm being accredited for this task. The team noted a water puddle at the bottom level in the container (pointed out by the representative of the Environment Agency).

The team was informed that the upstream Calder River sampling site at Calder Bridge is located in a secure compound belonging to Sellafield Ltd.; besides a similar surface water sampling device it also contains a HiVol aerosol sampler. It was set up following the EC recommendation of 2004. Due to the completely changed system with automatic sampling and according recording devices the problems seen during the 2004 verification have been completely resolved.

The recommendation issued at the verification in 2004 is no longer pertinent.

However, the verification team suggests applying regular checks of installed equipment also by Sellafield staff with a view to control the contractor's work.

9 VERIFICATION ACTIVITIES – GENERAL ITEMS

9.1 DISCHARGE AUTHORISATION TRANSITION ISSUE

9.1.1 Conclusion of 2004 verification (Technical Report UK-04/1 chapter 6.1.)

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

9.1.2 2010 re-verification

The verification team received all information pertaining to the process of transition from the discharge authorisation based on the Radioactive Substances Act 1993 (RSA 93) to the one based on The Environmental Permitting Regulations (EPR) 2010.

The recommendation issued at the verification in 2004 is no longer pertinent.

9.2 (FORMER) GEOFFREY SCHOFIELD LABORATORY (2004: CHAPTER 10.1.15)

The verification of 2010 did not include the measurement laboratory that deals with environmental samples on behalf of the operator. During the visit of 2004 this was the Geoffrey Schofield Laboratory at the Westlakes Science and Technology Park. During the time of the 2010 verification the relevant tasks were taken up by an external contractor (Babcock's Nuclear Environmental Laboratory, based at the Westlakes Science and Technology Park).

Some items that led to recommendations in 2004 but are of more general validity with regard to the Sellafield site, are taken up in the respective chapter.

9.3 PROCEDURE WITH REGARDS TO DETERMINATION AND REPORTING OF VALUES BELOW DETECTION LIMITS IN PARTICULAR FOR DISCHARGES

9.3.1 Results of 2004 verification (2004 Main Findings 4.3.; Technical Report Chapter 10.1.15.)

Preamble: This recommendation was linked to the verification of the (former) Geoffrey Schofield Laboratory in 2004, which was not part of the 2010 verification. Since the subject is more general and the issue has been dealt with by EA and by Sellafield Limited in a more general way, the verification in 2010 again touched the issue.

> The verification team noted that the Lower Limit of Detection (LLD) for a gamma activity analysis frequently is determined by an algorithm associated to the EAGLE (Environmental Analysis of Gaseous and Liquid Effluents) database, based on the measurement result.
>
> *The verification team suggests exploring 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*

9.3.2 Comments by UK

Environment Agency 'Response October 2005':

'The use of detection limits in reporting radioactive discharges is currently under review as part of the European Commission Article 37 recommendation. A workshop was carried out with attendance from DEFRA, Environment Agency, NDA and Operators. The recommendation from this workshop [Ref 3] was to utilise ½ the decision threshold (¼ current LOD) to better represent the Limit of Detection when reporting discharge results. The implication of this recommendation has not been fully considered and hence, ongoing discussions are taking place between stakeholders.'

Sellafield Limited 'Current Position':

'The Environment Agency and Scottish Environment Protection Agency have published guidance on standardised reporting of radioactive discharges [Ref 4]. This guidance was developed jointly with the nuclear industry, including Sellafield Ltd. The guidance includes definitions of detection limit and decision threshold, often also referred to as Minimal Detectable Activity (MDA).

There is a long term intent to transfer all labs reporting to MDA protocol which will remove the requirement for user determination of LOD's – this is being managed by analytical liaison, and has commenced with the transition of contract lab gamma scan analysis. Reporting for Sellafield Ltd will be combined with current reporting requirements under the radioactive substances environmental permit and there will not be a separate reporting arrangement. The development of the reporting protocol is therefore being driven by the Environment Agency with full involvement from Sellafield Ltd to agree reporting protocols. The transition to the reporting protocol requires the reporting of analytical results as MDA by the analytical laboratory (see recommendation 2.4) in line with ISO standard.

This transition is ongoing, but has to be appropriately managed and will take some time to complete. An interim position has been agreed with the Environment Agency to allow Sellafield to implement the protocol using existing "A+/-B" results which necessitate user determination of the LOD.'

9.3.3 Results of 2010 verification

During the visit regarding the EAGLE database the verification team was explained that the issue has been taken up in a more general way, developing a solution valid for the whole UK.

Currently, still if a result is smaller than the detection limit then the detection limit is reported as result. This approach will be replaced by reporting 'zero' as result.

Sellafield Ltd. currently is in the process of changing the system of determination from calculation of detection limits by EAGLE towards numbers being supplied by the analysis laboratory. EA uses the EC discharge recommendation as guidance for such calculation. The team was told that this is a slow transition; it will be ready by 2011. Considerable changes have to be made in the data base, for example all results have to be treated as 'real'. Sellafield Ltd. sees an advantage that – compared to the 'old' system – the 'new' approach virtually 'reduces' discharges, but the change is a slow quality assured process.

EA agreed on the new approach. There was also a DEFRA consultation on this topic and no concern was raised. EA notes that changing the approach for LLDs could have an impact with regard to acceptance by NGO's; however these were involved by DEFRA in the design of the changes and did not react. Sellafield's techniques document concerning detection limits will be updated; a list of "best practices" for determination of detection limits for the plants will be placed in this document; subsequently the new version has to be accepted by EA.

The recommendation issued at the verification in 2004 is no longer pertinent, since the issue has been taken up and according work has begun. The verification team encourages the full implementation of the newly developed guidance on reporting of values below the detection limit.

9.4 ACCESS TO EAGLE DISCHARGE DATA BASE BY ANALYSIS LABORATORY

9.4.1 Results of 2004 verification (2004 Main Findings 4.4.; Technical Report Chapter 10.1.15.)

Preamble: This recommendation was linked to the verification of the (former) Geoffrey Schofield Laboratory in 2004, which was not part of the 2010 verification. Since the subject is more general and the issue has been dealt with by EA and by Sellafield Limited in a more general way, the verification in 2010 again touched the issue.

Geoffrey Schofield Laboratories has no access to the EAGLE database. *The verification team recommends giving the analysis laboratory access to the EAGLE database.*

9.4.2 Comments by UK

Environment Agency 'Response October 2005':

'Access to the EAGLE database is given to BNGSL employees as appropriate. The Geoffrey Schofield Laboratory has become an external contractor since the Article 35 verification and as such it is not the intention to provide access to the EAGLE database at this time. However, individual applications are considered on merit.'

Sellafield Limited 'Current Position':

'It is not appropriate for the contract lab to have access to the EAGLE database. It is a discharge reporting tool, and not a lab information management system. It contains discharge information which it would not be appropriate for an external organisation to have direct access to.'

9.4.3 Results of 2010 verification

The verification team was explained that the organisational structure has been changed (the analysis laboratory is now an external contractor) and why Sellafield Ltd. would not give access to the EAGLE data base to such external bodies. It understands the underlying reasoning.

Due to the changed organisational setup the recommendation issued at the verification in 2004 is no longer pertinent.

9.5 UPDATING DOCUMENTATION, E.G. WITH REGARD TO RENAMING FROM BNFL TO SELLAFIELD LTD.

When looking through the documentation received during the visit the verification team noted that some of the documents used 'old' names and logos. For example, on some document headers the logo still showed 'BNFL'. The team sees a 'legal risk' if such documents have to be used for legal purposes although the content is technically sound and still used for operational work.

The verification team recommends thoroughly checking all documents with regard to using current organisational names and logos in particular in their headers with a view to avoid possible legal problems.

9.6 'BEACH PARTICLES' ISSUE

The verification team received a short presentation on the situation of detection of 'beach particles'. Such particles could originate from decommissioning of Sea Line 1. In a way similar to the approach at Dounreay a special vehicle is used with a sensitive measuring device attached. The new device consists of a carbon fibre box with a large volume NaI(Tl) detector, plus seven FIDLER (Field Instrument for Detecting Low Energy Radiation) probes. Until now ca 1000 particles were found – 40% connected to stones. Monitoring is performed mainly in an area several kilometres north of Ravenglass (public access); further north the area is military.

Verification does not give rise to any specific recommendations.

9.7 SELLAFIELD FIRST GENERATION MAGNOX STORAGE POND

The verification team could shortly discuss the situation of the First Generation Magnox storage pond storing old Magnox fuel. Many ideas have been proposed to reduce radiation risk during the works in that area, most however were discarded. For example, placing a net over the pond would risk that objects may fall into it. Construction of a dome like shelter would lead to an unacceptable exposure of workers. Building up such a facility in the vicinity and then moving it is prohibited by the neighbouring buildings. The best option currently seen is 'keeping the issue as short as possible'.

10 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 showed that – for the facilities visited – the recommendations laid down at the verification in 2004 have been taken up or reasons for not implementing them have been reasonably given. Thus, the recommendations are no longer pertinent.

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

(3) However, a few recommendations and suggestions are formulated. These aim at improving some aspects of the surveillance of the Sellafield site. They 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.

(4) 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.

(5) The Commission Services ask the UK competent authority to inform them of any achievements with regard to the situation at the time of the verification.

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

APPENDIX 1

REFERENCES & DOCUMENTATION

Some of the documents cited below were already available at the 2004 verification mission.

EA (Environment Agency) and FSA (Food Standards Agency)

- Radioactivity in Food and the Environment, annual RIFE reports – issued by EA + FSA + SEPA +NIEA

These reports are also available on the Environment Agency and Food Standards Agency websites: www.environment-agency.gov.uk and www.food.gov.uk

- EA – Radioactivity in the environment, report for 2000 – ISBN 1857056930
- EA – Radioactivity in the environment, report for 2001 – ISBN 1844320618
- EA + FSA – Article 35 verification visit to Sellafield – EA and FSA monitoring programmes (MAPG/TR/2004/001, January 2004).
- Radioactive Substances Act 1993 – certificates of authorisation and variation pertaining to the BNFL Sellafield site, Seascale, Cumbria.
- Radioactive Substances Act 1993 – liquid effluent authorisation implementation document – disposal of liquid waste to sea from the premises of British Nuclear Fuels plc at Sellafield (issue 2, revision 3, January 2003).
- Radioactive Substances Act 1993 – aerial effluent authorisation implementation document – disposal of low level waste gases, mists and dusts from the premises of British Nuclear Fuels plc at Sellafield (issue 1, revision 5, May 2003).
- EA - Radioactive Substances Act 1993 decision and summary documents: proposed decision for the future regulation of disposals of radioactive waste from British Nuclear Fuels plc Sellafield, August 2002 (ISBN 1857059107).
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- The Regulation of Radioactive Waste Disposals from Sellafield under the Radioactive Substances Act 1993 (EA presentation).
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- Sellafield site procedure SSP 2.01.05: management of radioactive liquid waste (issue 01, 12/2003).
- Sellafield site procedure SSP 2.01.10: management of discharge records for aerial and liquid effluents and environmental monitoring and assessments (issue 01, 10/2003).

- Low active effluent management group: conditions for acceptance – site low active liquid effluent discharge controls (issue 01, 05/2003).
- Design Guide BNF.EG.0005-1-B: gamma radiation monitoring – monitoring in operational plant areas (issue 07/03).
- Design Guide BNF.EG.0005-4-B: stack and duct sampling and monitoring principles (issue 04/03).
- Design Guide BNF.EG.0005-7-B: cooling water and steam condensate activity monitoring (issue 05/03).
- Standard BNF.ES.0005-10-A: stack sampling and analysis for Ru-106 (issue 04/03).
- Standard BNF.ES.0005-11-A: stack sampling and monitoring for I-129 and other volatiles (issue 04/03).
- Standard BNF.ES.0005-12-A: stack sampling and monitoring for H-3 and C-14 (issue 04/03).
- Standard BNF.ES.0005-13-A: stack sampling for particulate activity (issue 04/03).
- THORP aerial and liquid effluent overview (presentation).
- THORP group, department procedure DP 6.03: management and control of liquid (radioactive) effluents and liquid (radioactive) waste (issue 06, 10/2002).
- THORP group, department procedure DP 6.04: management and control of gaseous (radioactive) wastes (issue 03, 05/1998).
- THORP head end and chemical plants quality plan QP/02/002: controls in place to discharge effluents from V2272 to the break pressure tank (issue 14, 04/2000).
- THORP receipt and storage quality plan QP/OFSG/B560/13: management and control of low active effluent discharges from receipt and storage and feed pond purge (issue 02, 11/2000).
- THORP receipt and storage operating instruction OI/01/0073: feed pond operations – sample cabinet operation.
- THORP procedure DI 6.04-FSS007: arrangements for the management of radioactive aerial effluent discharges (issue 1, 03/1999).
- THORP operator instruction OI/02/0026: dissolver – V2100A-C shear pack wash operations (issue 12, 10/2003).
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- THORP operator instruction OI/02/0228: C-14 – V2272 transfer supernate to the break pressure tank (issue 16, 07/2002).
- THORP operator instruction OI/02/0579: C-14 plant – operation of the C-14 removal plant (issue 02, 02/2003).
- SIXEP: daily sampling to control activity to sea.
- SETP operator instruction SETP/OI/54: operation of the sea tank proportional samplers (issue 10, 09/2003).
- SETP operator instruction SETP/OI/62: pumping liquor from the sea tanks to the break pressure tank (issue 09, 12/2002).
- SMP: overview ventilation systems + sampling nozzle drawings.
- SMP: stack commissioning references + system performance demonstration.
- SMP quality plan SMP/QP/006: the management and control of trace-active liquid effluent discharges from SMP to THORP low active effluent plant (LAEP) (issue 04, 05/2002).
- SMP quality plan SMP/QP/011: measurement and control of SMP aerial effluent discharges (issue 03, 05/2002).
- SMP operator instruction OI/700/09: arrangements for operation of stack monitoring equipment (issue 06, 02/2003)
- Monitor instruction THORP/3.15/B: SMP stack and duct filter card change (issue 01, 02/2003).
- Analytical schedule AS/B572/SMPLAE: SMP liquid and aerial effluents (issue 01, 11/2003).
- Magnox east river quality plan QP/FHP/319: control of liquid effluent discharges FHP, SIXEP, B350 (issue 07, 07/2003).
- EARP operator instruction EARP/COI/4S1: bulks sentencing: sea discharge fill tank selection, recycle and discharge operations (issue 05, 12/2003).
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- Technical specification and user guide: Harwell alpha particulate-in-air monitor 974014-1.
- Product description: BAI 9300-A alpha detector.
- Statutory environmental monitoring returns, 3rd quarter 2003 (EMA-ST3/L/A/03).
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- Instruction R&T-I-T: groundwater purging and sampling using the “low flow” (micropurge) methodology (rev 11/98).
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- QAAM726_Detn Pu Isotopes in Liq Eff Spls.pdf
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- QAAM102_Detn Tc99.pdf
- QAAM101_Detn Sr89 Sr90 Process Solns.pdf
- QAAM099_Detn H3.pdf
- Liquid Effluent Report 2009.doc
- Aerial Discharges 2009.doc
- CFA_33 LAEMG Low Active CFA.pdf
- EARP_COI_17P Concentrates Sampling.pdf
- EARP_COI_19P Bulks Sampling.pdf
- LECI_001 Site Triggers.pdf
- SETP_OI_54 Sampling.pdf
- SI_121 Sentencing Checks.pdf
- C14 and H3 Sampler - System 4 Matrix.doc
- DI 6.03 - Management liquid effluents and liqu.pdf
- DI 6.04 - control of NOx discharges fr.pdf
- DP 6.04 - Management and Control of Gaseous Wastes.pdf
- Maypack Sampler - System 2 Matrix.doc
- OI-08-0950.PDF
- OI-08-0951 - Stack Coordinator Instruction.pdf
- OI_01_0560 Feedpond operations proportional sampler.pdf
- Particulate Sampler - System 1 Matrix.doc
- QP02002 - Quality Plan.pdf
- Ru106 Sampler - System 3 Matrix.doc

European Commission- Radiation Protection Unit

- Technical Report UK 04/1 and associated Main Findings document

Others

- UKAS report 20 - 22.10.09.pdf

APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY

Sunday 22/8

EC party travels from Luxembourg/Karlsruhe to UK (first by plane to Newcastle; then to Sellafield by rented car).

Monday 23/8

1. Arrival at the Sellafield site (09:00)
2. Site access formalities (AM)
3. Opening meeting: introductions / presentations / programme of the visit. (AM)
4. Verification of the provisions for on site environmental monitoring / sampling. (PM)

Tuesday 24/8

5. Verification of the provisions for aerial discharge estimates: approved places methodology. (AM)
6. Verification of the on-site laboratory/ies (environmental and discharge samples). (PM)

Wednesday 25/8

7. Verification of the provisions for liquid discharge monitoring: EARP. (AM)
8. Verification of the provisions for liquid discharge monitoring: SETP. (PM)

Thursday 26/8

9. Verification of the provisions for aerial and liquid discharge monitoring: THORP. (AM)
10. Verification of the provisions for aerial and liquid discharge monitoring: THORP (cont.). (PM)
11. Closing meeting: presentation of preliminary verification findings. (ca. 17:00)

Friday 27/8

Return travel to Luxembourg/Karlsruhe (by rented car; plane). (PM)

European Commission team: Constant Gitzinger, Eberhardt Henrich, Erich Hrnecek

Leader: Constant Gitzinger

APPENDIX 3

DESCRIPTION OF VISITED INSTALLATIONS LEADING TO RADIOACTIVE DISCHARGES AT THE SELLAFIELD SITE AND RESULTS OF THE 2004 VERIFICATION

Preamble: The EC team performed a verification of facilities for the control of gaseous and liquid discharges, based on the results of the verification of 2004 (Technical report UK-04/1). For ease of comparison the text describing the management of radioactive discharges at the Sellafield site and the text describing the verification activities in 2004 are given as citations (chapters 6 and 7 respectively of that report), using a smaller font and a frame. Document names and numbers have not been changed and thus may still relate to the system used by British Nuclear Fuels Limited (BNFL).

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:

  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.

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

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.

- Management of aerial effluent discharge data.

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.

- Management of aerial effluent discharge monitoring arrangements.

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. Duplicate Alpha/Beta monitors (on C3, C5 GB and VV ducts. Alpha only on DOG) – 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

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(3) See appendix 4 *(of the 2004 Technical Report)* for a summary diagram.

(4) See appendix 5 *(of the 2004 Technical Report)* 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 *(of the 2004 Technical Report)* for an extensive list of these monitoring systems. This list is a summary of the relevant part of the Aerial Effluent Authorisation Implementation document.

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 - *of the 2004 Technical Report*). The team also verified to its satisfaction that the operational and measurement parameters as described in appendices 5 and 6 - *of the 2004 Technical Report-* 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.
- 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 m^3 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 m³ 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 m^3), 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.

APPENDIX 4

DESCRIPTION OF THE SELLAFIELD ANALYTICAL SERVICES LABORATORY AND RESULTS OF THE 2004 VERIFICATION

Preamble: The EC team performed a verification of the Analytical Services Laboratory at the Sellafield site, based on the results of the verification of 2004 (Technical report UK-04/1). For ease of comparison the text describing the laboratory as visited and the text describing the verification activities in 2004 are given as citations (chapter 8 of that report), using a smaller font and a frame. Document names and numbers have not been changed and thus may still relate to the system used by British Nuclear Fuels Limited (BNFL).

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) and the 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 backgrounds 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.