EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

DOUNREAY

CAITHNESS, SCOTLAND (UK)

28 to 30 September 2004

Reference: UK-04/3

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Installations for monitoring and controlling radioactive discharges and for surveillance of the environment in the North of Scotland during normal operations of the UKAEA Dounreay nuclear site.
SITE:	Caithness District, Scotland (United Kingdom).
DATE:	28 to 30 September 2004.
REFERENCE:	UK-04/3.
INSPECTORS:	C. Gitzinger (Head of team) S. Van der Stricht E. Henrich (national expert on secondment – Austria)
DATE OF REPORT:	Final report agreed upon with the United Kingdom competent authorities on 05/10/2005.
SIGNATURES:	

[signed[

C. Gitzinger

[signed[

S. Van der Stricht

[signed[

E. Henrich

APPENDICES

TECHNICAL REPORT

1. ABBREVIATIONS

CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CSS	Chemistry Support Services
DEFRA	Department for Environment, Food & Rural Affairs
DFR	Dounreay Fast Reactor
DG TREN	Directorate-General for Transport and Energy (of the EC)
EA 95	Environment Act 1995
EC	European Commission
EMTT	Environmental Monitoring Task Team
EPA 90	Environmental Protection Act 1990
FCA	Fuel Cycle Area
FEPA	Food and Environment Protection Act (1985)
HEPA	High Efficiency Particulate Air (filter)
HMIPI	Her Majesty's Industrial Pollution Inspectorate for Scotland
HSE	Health and Safety Executive
ILW	Intermediate Level Waste
LAD	Low Active Drain
LLLETP	Low Level Liquid Effluent Treatment Plant
LLW	Low Level Waste
MAFF	Ministry of Agriculture, Fisheries and Food
MHWS	Mean high water springs
MLWS	Mean low water springs
NRPB	National Radiological Protection Board
PFR	Prototype Fast Reactor
RIFE	Radioactivity in food and the environment (report)
RIMNET	Radiation Incident Monitoring Network
RSA 93	Radioactive Substances Act 1993
SE	Scottish Executive
SDP	Sodium Disposal Plant
SEPA	Scottish Environment Protection Agency
TID	Technical Implementation Document
UKAEA	United Kingdom Atomic Energy Authority
UPS	Uninterruptible Power Supply
WRACS	Waste Receipt Assay Characterisation and Supercompaction facility

2. INTRODUCTION

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

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

For the EC, the Directorate-General for Transport and Energy (DG TREN) and more in particular its Radiation Protection Unit (TREN H4) 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 (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

A verification team from DG TREN visited (28 to 30 September 2004) the Dounreay site located on the northern coast of the Caithness District in Scotland. The United Kingdom Atomic Energy Authority (UKAEA) operates the site.

The visit also included meetings with representatives of the Scottish Executive (SE) and the Scottish Environment Protection Agency (SEPA).

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

The present report is also based on information collected from documents received and from discussions with various persons met during the visit.

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1. Preamble

The Commission's decision to request the conduct of an Article 35 verification was notified to the United Kingdom Government on 22 July 2004 (letter referenced TREN/H4/SVdS/jf D(2004)12374, addressed to the United Kingdom Permanent Representation to the European Union).

In this letter the EC informed the UK Permanent Representation about its intention to restrict the scope of the 2004 Dounreay visit to a follow-up of the verification activities performed in March 1999 and resulting recommendations [(2)].

The UK Government subsequently designated the Scottish Executive to lead the technical preparations for this visit.

1 Directive 96/29/Euratom.

2 The report and main findings of the 1999 verification can be downloaded from: http://europa.eu.int/comm/energy/nuclear/radioprotection/verification_en.htm

3.2. Programme of the visit

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

It was agreed that the programme of verification activities would focus on:

- Follow-up of the 1999 verification recommendations [3], implementation thereof.
- Modifications to the environmental monitoring programme since 1999.
- The monitoring of airborne discharges from:
    - the Fuel Cycle Area (FCA);
    - the Marshall Laboratory;
    - the Effluent Laboratory;
    - the Sodium Disposal Plant (SDP);
    - the Waste Receipt Assay Characterisation and Supercompaction facility (WRACS);
    - the Low Level Liquid Effluent Treatment Plant (LLLETP).
- The monitoring of liquid discharges from the LLLETP.

During the opening meeting held on 28/09/2004 presentations were given on the following topics:

- Review of the 1999 EC recommendations (by SEPA).
- A progress review on the presence of radioactive particles in the marine environment (by UKAEA).
- A progress review on the waste shaft (by UKAEA).

A summary overview of the programme of verification activities is provided in Appendix 1.

The verifications were carried out in accordance with the programme.

3.3. Documents

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Scottish Executive. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 2 to this report. The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

The information thus provided has been extensively used for drawing up the descriptive sections of the report.

3.4. Representatives of the competent authorities and the operators

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

3 Those recommendations that were related to environmental monitoring and monitoring of radioactive discharges.

The Scottish Executive:

Dr Ian Hall	Specialist Advisor Radioactive Waste
Louise Wright	Radioactive Waste Team Administrator
Sara Stewart	Radioactive Waste Team Administrator
Elisabeth Gray	Radioactive Waste Team Leader

The Scottish Environment Protection Agency:

Dr Paul Dale	Specialist, Radioactive Substances Policy Unit
Dr George Hunter	Radioactive Substances Policy Unit Manager
Roger Wilson	Radioactive Substances Field Operations Team
Adam Stackhouse	Technical Support Officer, Radioactive Substances Policy Unit

The United Kingdom Atomic Energy Authority:

Norman Harrison	Dounreay Director
Guy Owen	Head of Safety, Health, Environment and Quality Group
Fiona Forbes	Assistant to the Head of Safety, Health, Environment and Quality Group
Mark Liddiard	Senior Project Manager, Environmental Projects
Warren Jones	Senior Project Manager, Shaft Isolation
Mark Raffle	Senior Project Manager, Effluent Management Projects
Joe Toole	Project Manager, Particle Monitoring
Angel Lockhart	Discharge Authorisation Compliance Officer
Carol Walford	Discharge Authorisation Compliance Officer
David Lord	Environmental Compliance Manager
Susan Somerville	Environmental Monitoring Officer
Alex Macdonald	Laboratory and Facility Support Manager
Mark Whale	Waste Operation Manager, Solid LLW
David Bremner	Assistant Waste Operation Manager, Solid LLW
Graeme Beaven	Facility Manager D1213
Derek Richardson	Assistant Waste Operation Manager, Liquid & Gaseous LLW
Graeme Rennie	Facility Manager, WRACS
William Gunn	Supervisor, WRACS
Leonard Mason	Facility Manager, PFR
Wendy Meikle-John	Safety Support Assistant, PFR
Michael Tait	Manager LLLETP, D1211 and LAD Areas
Colin Macdonald	Shift Operations / Emergency Planning Support & D2670 Manager
David Webster	Building Manager, D2670
Ann Mair	Technical Support, Effluent and Radio-counting Manager
Charlie Stewart	Manager, Bio Monitoring Laboratories
Ann Ross	Laboratory Leader, Radiometric
Fiona Low	Laboratory Leader, Effluent
Nicola Shearer	Laboratory Leader, Environmental Wet Chemistry

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

4. LEGAL BACKGROUND & COMPETENT AUTHORITIES

4.1. Legal background

In the United Kingdom, the legal framework for the protection of the population and the environment against exposure arising from radioactivity discharges is based on the Radioactive Substances Act 1960 (RSA 60). RSA 60 was amended by the Environmental Protection Act 1990 (EPA 90) and consolidated under the Radioactive Substances Act 1993 (RSA 93), as amended by the Environment Act 1995 (EA 95).

The disposal of radioactive waste from nuclear establishments in Scotland is permitted, subject to limitations and conditions set out in Certificates of Authorisation granted by Scottish Environment Protection Agency (SEPA) under RSA 93 (as amended).

The Certificates of Authorisation determine the conditions and limits for the amount of radioactive substances discharged in solid, liquid 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 SEPA authorisations. Also included are provisions for monitoring programmes, including environmental monitoring and analysis.

Failure to comply with the Certificates of Authorisation is an offence under Section 32 of the Act.

4.2. The Scottish Environment Protection Agency

In 1995 the Scottish Environment Protection Agency (SEPA) was established under the Environment Act 1995 (EA 95). SEPA is a non-departmental public body that became operational on 1 April 1996 and was formed from a large number of predecessor bodies regulating environmental pollution and waste management of all types, not only radioactive substances. This merger gave SEPA additional strength by bringing together many specialisms and permitting the regulation of radioactive substances to be carried out in an integrated fashion within the constraints of the legislative and policy framework set by government.

SEPA's main duty is to protect the environment by controlling pollution to land, air and water in Scotland. This includes radioactive substances: regulating the use and disposal of radioactive substances, holding the national register for the use and disposal of radioactive substances, controlling discharges of radioactive waste from nuclear installations, managing the UK Radiation Incident Monitoring Network (RIMNET) in Scotland.

SEPA is also responsible for the monitoring of radioactivity in the environment. The environmental monitoring programme undertaken by SEPA is a unified programme from which the combined exposure pathways resulting from radioactive substances in the environment and foodstuffs [(4)] are considered together (for details see Appendix 3). The programme is developed and reviewed by a SEPA Project Group – the Environmental Monitoring Task Team (EMTT). EMTT membership includes SEPA Radioactive Substances Specialists and representatives of The Scottish Executive, the Food Standards Agency (FSA) and the National Radiological Protection Board (NRPB).

Contractors selected after competitive tender, undertake SEPA's monitoring programme. Contracts are signed for three years and contain requirements with regard to expected quality assurance and quality control. Presently the NRPB holds the contract. The results from the programme are made available to the public in an appropriate form, the annual Radioactivity in Food and the Environment (RIFE) Reports.

4.3. Discharge limits currently applicable to the Dounreay site

Current Certificates of Authorisation for the disposal of gaseous radioactive waste (certificate number RSA/N/50010/99), liquid radioactive waste (certificate number RSA/N/50011/99), and solid radioactive waste (certificate number RSA/50012/99) came into force on 16 August 1999.

Notices of variation were enforced on:

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[4] In Scotland SEPA monitors radioactivity in the food chain on behalf of the Food Standards Agency.

- 18/07/2003 (RSA/N/V01/50010/99 for gaseous radioactive waste)
- 8/04/2003 (RSA/N/V01/50012/99 for solid radioactive waste)

The notice of variation for discharges of gaseous radioactive waste of 18/07/2003 reduced the quantity of tritium that the site was allowed to release to the environment. It also permitted the operation of UKAEA's new facility for collecting and disposing of liquid waste to sea, the Low Level Liquid Effluent Treatment Plant (LLLETP). The LLLETP replaces the old sea discharge tanks that were the subject of a SEPA enforcement notice in January 2002.

The limits applicable at the time of the Verification, for the discharge of gaseous and liquid radioactive effluent by UKAEA Dounreay, are detailed in Appendix 4.

5. THE DOUNREAY SITE – SHORT DESCRIPTION OF PLANTS VISITED

This section deals with three plants that have been fully commissioned since the previous Article 35 verification visit of May 1999.

5.1. The Sodium Disposal Plant

The Dounreay Prototype Fast Reactor (PFR) was shutdown in March 1994 and decommissioning started. Within the turbine hall UKAEA built the Sodium Disposal Plant (SDP) to deal with the 1500 tonnes of sodium previously used as the reactor heat transfer medium (coolant). The SDP processes the sodium to produce a sodium chloride solution. This solution is then passed through a dedicated plant for the removal of residual caesium activity before discharge to sea.

It should be noted here that the former Sodium Disposal Plant, operated by AEA Technology, has been decommissioned in 2003 and the building demolished. This was achieved under authorisation granted by SEPA.

In this context it is worthwhile to remind that in its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

"The Sodium Disposal Facility, operated by AEA Technology is currently closed down under a SEPA Prohibition Notice served in 1997 because of inadequate facilities for monitoring and control of gaseous effluents (tritium in particular)".

"The verification team, after having paid a visit to the Sodium Disposal Plant to verify the existing effluent monitoring provisions and having witnessed the inadequacy of the current systems, considers the Prohibition Notice to be fully justified and recommends that remedial action be taken before resuming operation".

In its response to the verification findings the Scottish Executive stated:

"This is still the subject of a SEPA Prohibition Notice and AEAT are considering whether to upgrade this plant to bring the monitoring facilities to an acceptable standard or, alternatively, to transfer the waste to UKAEA for UKAEA to treat. The implications of this second option are currently being actively considered".

5.2. The Waste, Receipt, Assay, Characterisation and Supercompaction facility

The Waste, Receipt, Assay, Characterisation and Supercompaction facility (WRACS) prepares solid low-level radioactive waste (LLW) for interim storage or disposal.

Upon receipt of 200 litre steel drums containing LLW from Dounreay site operations, the facility checks the contents of these drums by using a real time X-ray radiography system. The drums can be rotated and jogged to help identify any liquids in them (the presence of liquids is prohibited). In order to detect beta-gamma emitters in the LLW the drums are passed through the Segmented Gamma Scanner. In order to detect alpha emitters the drums are then passed through the high sensitivity Alpha Assay System. All measurement results are recorded against the barcode attached to each drum. When the three tests are within the acceptance limits the drums are then compacted and their volume reduced on average to 5 to 1 (5). After compaction the drums are stacked in half-height ISO containers. When full the ISO container are fitted with a sealed lid and despatched for storage on site.

5.3. The Low Level Liquid Effluent Treatment Plant

The Low Level Liquid Effluent Treatment Plant (LLLETP) was commissioned in 2003 to replace the old D1211 discharge facility dating from 1957.

LLLETP collects, stores (interim), settles, neutralises and discharges to sea all low-level liquid effluents arising on the Dounreay site. Entrained solvents or immiscibles lighter than water can be separated and removed at the receipt or buffer tanks of the plant. Sludge (settled solids) arising at D3000 can be removed to a dedicated sludge handling facility for storage, characterisation and further treatment into solid waste. A two-stage neutralisation process ensures that the pH of the effluent discharged to sea is kept between pH 5 and 9. The discharge tanks (2 tanks of 550 m^3) operate on a batch basis.

6. MANAGEMENT OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT

UKAEA are required as a condition of their authorisations issued under RSA 93 to monitor and report on the levels of certain named radionuclides in all of the waste discharged. At Dounreay liquid and gaseous waste disposals are made to the environment, solid wastes are retained on site.

UKAEA's radiochemical laboratories, where effluent samples are analysed, achieved ISO9001 accreditation in 1994 and achieved the more stringent UKAS accreditation in 2000.

6.1. Liquid discharges

Low-level liquid waste is analysed and sentenced at the originating plant before being dispatched to the Low Level Liquid Effluent Treatment Plant (LLLETP). Low level liquid radioactive waste is discharged (after sampling and analysis) from one of two sea discharge tanks to the Atlantic Ocean via a pipeline ending 600 m beyond high water mark at a depth of 24 m.

The sampling regime and analytical procedures applicable to LLLETP liquid discharges are fully detailed in the Technical Implementation Document (TID) to the Authorisation (Appendix 2, ref. 9).

In summary:

During the filling of a SDT a proportional sample is taken (the "A" sample) to confirm that the tank's contents can be discharged to sea within the confines of the limits set in SEPA's Authorisation. The sampled discharge tank is allowed to stand for at least 24 hours to enable settling of any remaining solids before discharge. The discharge then proceeds (during high water to allow maximum dispersion) and is proportionally sampled, the "B" sample. The "B" samples are used to prepare a

[5] Should a drum fail any of the acceptance criteria the drum is returned intact to its point of origin to be dealt with by its original consignor.

weekly bulk sample as a pro rata to the volume discharged (1 ml per m^3 sent to sea). Monthly samples are prepared by bulking one litre of each weekly sample, for four or five weeks. The analysis results of the monthly bulk sample are reported to SEPA. Samples of effluent are obtained by SEPA (bimonthly) for independent analysis by SEPA's contractor (NRPB).

6.2. Airborne discharges

The Certificate of Authorisation discerns between various discharge points and defines discharge limits for each of these. The following discharge points are listed:

- the Prototype Fast Reactor (PFR),
- the Dounreay Fast Reactor (DFR),
- the PFR Minor Sources (3 stacks),
- the Fuel Cycle Area (FCA) Stack,
- the West Minor Sources (4 stacks),
- the East Minor Sources (10 stacks).

An overview of the spatial distribution of these discharge points is given in Appendix 5.

The sampling regimes and analytical procedures applicable to these discharge points are fully detailed in the Technical Implementation Document (TID) to the Authorisation (Appendix 2, ref.8).

In summary:

Sampling of particulate matter on suitable filters is performed in continuous mode on all stacks. Filters are exchanged on a weekly basis and measured for collected total alpha and total beta activity (solid source counting).

Where applicable, the sampling of tritiated water vapour and tritium gas is performed in continuous mode using bubblers, the bubblers are exchanged weekly and tritium assessed using liquid scintillation counting (FCA main stack, PFR, DFR and LLLETP). The discharge of tritium is not sampled/analysed but calculated for the D8530 analysis laboratory which is part of the West Minor Sources.

For the FCA main stack, additional high-resolution alpha and gamma spectrometry is performed on monthly bulked particulate filters to assess individual radionuclides. On this same stack the discharge is also continuously sampled for I-131, the filter being exchanged weekly and assessed using high-resolution gamma spectrometry.

Noble gases are sampled at DFR and assessed using high-resolution gamma spectrometry. For the FCA main stack, PFR and the East Minor Sources the discharge of Kr-85 is not sampled and analysed but calculated.

The analytical methods used to asses samples or calculate discharges are described in the Chemical Support Services' Quality Assurance Plans, numbers CSS/QP/01, CSS/QP/03, CSS/QP/06, CSS/QP/14 and CSS/QP/21 (Appendix 2, refs. 23 to 27).

Analytical results are reported to SEPA on a monthly basis.

7. VERIFICATION ACTIVITIES - RADIOACTIVE DISCHARGES

7.1. WRACS – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted:

(1) One ventilation systems discharges into a single stack of a height of 13m. There is a further three stack penetrations: the stack sampling penetration, the sample return leg and the pitot tube for stack flow rate measurement.
(2) The sampling system is located inside a locked sample cabinet at the base of the stack.
(3) Sampling is continuous and performed downstream of a HEPA filter bank.
(4) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged on a weekly basis. Both particulate alpha and particulate beta radioactivity are routinely assessed (weekly).
(5) The system’s design ensures isokinetic sampling.
(6) The sampling lines are wrapped in isothermic mantles.
(7) Redundant equipment is present in case of failure (i.e. dual pumps with automatic change over).
(8) Flow meters and totalisers are present on the discharge duct and sampling lines.
(9) Stickers on the samplers showing the latest calibration date.
(10) All pieces of equipment are labelled with individual reference numbers.
(11) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(12) In case of power failure a back-up diesel generator is available.

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

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from WRACS are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.2. SDP – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted:

(1) Three ventilation and extraction systems discharge into a single stack of a height of 40 m.

For each of these three ventilation systems:

(2) The sampling systems are located inside a locked sample cabinet.
(3) Sampling is continuous.
(4) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged on a weekly basis. Both particulate alpha and particulate beta radioactivity are routinely assessed (weekly).
(5) The system’s design ensures isokinetic sampling.

(6) Tritium is sampled with a statutory Roxspur system and sample bottles exchanged on a weekly basis. Both tritiated water vapour and tritium gas is assessed weekly.
(7) Each sampling system is backed up by redundant equipment in case of failure (i.e. dual pumps with automatic change over).
(8) Flow meters and totalisers are present on the discharge duct and sampling lines.
(9) Stickers on the samplers showing the latest calibration date.
(10) All pieces of equipment are labelled with individual reference numbers.
(11) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(12) In case of power failure a back-up diesel generator is available.

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

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from SDP are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.3. LLLETP – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted that:

(1) The ventilation and extraction systems discharge into a single stack of a height of 17m.
(2) The sampling systems are located inside a locked sample cabinet at the base of the stack.
(3) Sampling is continuous and performed downstream of a HEPA filter bank.
(4) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged on weekly basis. Both particulate alpha and particulate beta radioactivity are routinely assessed (weekly).
(5) The system's design ensures isokinetic sampling.
(6) Tritium is sampled with a statutory Roxspur system and sample bottles exchanged on a weekly basis. Both tritiated water vapour and tritium gas is assessed weekly.
(7) The tritium sampler is checked daily: a ledger to that effect was present.
(8) Each sampling system is backed up by redundant equipment in case of failure (i.e. dual pumps with automatic change over).
(9) Flow meters and totalisers are present on the discharge duct and sampling lines.
(10) Stickers on the samplers showing the latest calibration date.
(11) All pieces of equipment are labelled with individual reference numbers.
(12) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(13) In case of power failure a back-up diesel generator is available.

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

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from LLLETP are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.4. LLLETP – liquid discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted that:

(1) Site effluent is initially collected in the Gravity Receipt Tank from where it is automatically transferred to the Buffer Tank. Sludge and solvent monitoring is carried out in the former vessel.
(2) The Buffer Tank is operated at low capacity; this allows for a 3-day buffer capacity of the plant.
(3) The Buffer Tank contents are subsequently transferred to one of two Sea Discharge Tanks (SDT) via the neutralisation (pH) system.
(4) During the filling of a SDT a proportional sample is taken (A-sample / sentencing sample) by an automated sampling system. The sampler is a W35001 Bühler-Montec type Xantos 4000. Sample bottles (3 litre capacity) are clearly labelled (relationship to the SDT + date). The A-sample is transferred to the analytical laboratory and the results obtained are reported to the Site Shift Manager (SSM) who authorises the discharge.
(5) The SDT to be discharged to sea is subject to a settlement period of at least 24 hours.
(6) The SDT is discharged to sea within the allotted tide window under the direct control of the SSM or the D3000 Facility Manager.
(7) As the SDT is discharging a representative B-sample is taken automatically (proportional sampler). The B-sample is used for retrospective accountancy of activity discharged. B-samples are furthermore bulked (pro rata to the volume of effluent discharged) into weekly and monthly samples. The monthly bulk sample results are transmitted to the regulator (SEPA).
(8) The B-sample is used for statutory purposes, however it also serves as a reassurance sample.
(9) The B-sample sampler has functionality alarms that warn operations at a flow of 10 dm^3/minute and automatically stops the discharge when the flow through the sampler drops below 5 dm^3/minute.
(10) In case of power failure, back-up diesel generators are available that feed the receipt pumps.
(11) As per TID, the UKAEA intends to install a particulate filter before the B proportional sampler. This device is scheduled for commissioning before the end of 2004. This filter should retain any suspended particle with a diameter above 60 µ.

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

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of liquid radioactivity from LLLETP are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.5. Marshall Laboratory – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted that:

(1) Four separate ventilation systems, individually labelled, discharge into a single stack of a height of 21m.

For each of these four ventilation systems:

(2) Sampling is continuous and performed downstream of a HEPA filter bank.
(3) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged on a weekly basis. Particulate alpha and beta radioactivity is routinely assessed (weekly).

The 1999 art.35 verification recommendation to the effect that UKAEA put in place adequate alpha monitoring for gaseous effluents from the Marshall Laboratory has been satisfactorily implemented.

(4) The system's design ensures isokinetic sampling.
(5) Each sampling system is backed up by redundant equipment in case of failure (i.e. dual pumps with automatic change over).
(6) Flow meters and totalisers are present on the discharge duct and sampling lines.
(7) Stickers on the samplers showing the latest calibration date.
(8) All pieces of equipment are labelled with individual reference numbers.
(9) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(10) In case of power failure a back-up diesel generator is available.

The verification team considers the sampling equipment for airborne effluents from the Marshall Laboratory to be adequate and the programme of airborne effluent sampling to be satisfactory.

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from the Marshall Laboratory are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.6. FCA (main stack) – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted that:

(1) The ventilation and extraction systems from the Fuel Cycle Area (FCA) discharge into a single stack of a height of 55 m. The sample duct nozzle is located at a height of approximately 30 m.
(2) The individual sampling systems are located inside two cabinets at the base of the stack.
(3) Sampling is continuous.
(4) The sampling system's design ensures isokinetic sampling.
(5) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged daily. Particulate alpha and beta radioactivity is assessed routinely (daily) and analysed as part of the monthly bulk sample. Also assessed (monthly, on bulked samples) are gamma emitting radionuclides, Pu-241, Sr-90, I-129, Cm-242 and Cm-244.
(6) Tritium is sampled with a statutory Roxspur system and sample bottles exchanged on a weekly basis. Tritiated water vapour and tritium gas is assessed weekly.
(7) Iodines are sampled using a Maypack carbon granulate filter that is exchanged weekly. I-131 is assessed weekly.
(8) Aerosol (particulate) and Iodine sampling systems are backed up by redundant equipment in case of failure (i.e. dual pumps with automatic change over).

(9) Flow meters and totalisers are present on the discharge duct and sampling lines.
(10) Stickers on the samplers showing the latest calibration date.
(11) All pieces of equipment are labelled with individual reference numbers.
(12) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(13) In case of power failure sampling continues, powered initially by an UPS. A back-up diesel generator is available.

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

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from the FCA main stack are monitored as specified in the Certificate of Authorisation and the related Implementation Document.

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

7.7. D1200 (minor stack) – airborne discharges

The verification team confirmed the existence and functionality of all the sampling provisions as defined in the regulatory obligations.

The verification team noted that:

(1) Two separate ventilation/extraction systems discharge into a single stack of a height of 18 m. One flue within the stack extracts from a number of D1200 laboratories (north side) fume cupboards, the other flue extracts from the D1215 plutonium analysis laboratory fume cupboards and the balance of D1200 (north side) fume cupboards.

For each of these two ventilation/extraction systems:

(2) The sampling systems are located inside a locked sample cabinet at the base of the stack.
(3) Sampling is continuous.
(4) Aerosols are filtered across a statutory 40mm Bird & Tole filter card that is exchanged on weekly basis. Both particulate alpha and particulate beta radioactivity are assessed (weekly).
(5) The system's design ensures isokinetic sampling.
(6) Each sampling system is backed up by redundant equipment in case of failure (i.e. dual pumps with automatic change over).
(7) Flow meters and totalisers are present on the discharge duct and sampling line.
(8) Stickers on the samplers showing the latest calibration date.
(9) All pieces of equipment are labelled with individual reference numbers.
(10) The sampling systems are alarmed in case of malfunction. Fault alert is relayed into a permanently manned station.
(11) In case of power failure a back-up diesel generator is available.

The verification team considers the sampling equipment for airborne effluents from D1200/D1215 to be adequate and the programme of airborne effluent sampling to be satisfactory.

Quality control is implemented through a compilation of comprehensive written operational procedures.

The verification team considers that discharges of airborne radioactivity from the D1200 minor stack are monitored as specified in the Certificate of Authorisation and the related Technical Implementation Document.

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

7.8. On-line monitoring systems

The verification team noted the presence, at all above locations, of additional non-statutory aerosol samplers. For a certain number of stacks these devices (filters) are linked to detectors that continuously assess particulate activity and that transmit the monitoring data into the related operation control rooms. Their purpose is to function as alarm raisers in case of transgression of pre-set activity concentration values (limits).

The verification team was told that the filters of these (alarming) monitor systems may serve as back-up in case of a failure of a statutory sampler (at the same location). Similarly, the filters from the monitors may serve as back-up in case of problems with analytical procedures on the statutory discharge samples at the laboratory.

The verification team noted that these monitoring systems (that are linked to the same sampling line system as the statutory samplers) were not always clearly labelled as such. This was especially the case at the FCA cabinet containing sampling as well as monitoring devices. This led to some confusion as regards their unequivocal identification as being non-regulatory equipment.

It is suggested, with respect to matters of general quality assurance, that in those cases where both statutory and non-statutory devices are located adjacent to each other, their labelling be of such a nature that identification mistakes are avoided.

7.9. Effluent analysis laboratory

7.9.1. Introduction

The laboratory is UKAS accredited [6] according to ISO 17025 for most of the analytical methodologies applicable to the statutory discharge samples.

Quality assurance and control is managed through written documentation, of which CSS/QP/03 (quality plan for discharge analysis) is the cornerstone. The purpose of this quality assurance plan is to ensure that the effluent analysis laboratory maintains acceptable quality requirements by ensuring that:

- The appropriate high standards of chemical analysis are achieved and maintained.
- Appropriate approved procedures are used for each analysis type.
- The necessary records are generated and maintained and are available to demonstrate that the appropriate requirements are complied with.
- Reported results can be reliably traced to both sample origin and relevant quality control data.
- Results are reported to appropriate personnel and within appropriate time scales.

The scope of quality assurance plan CSS/QP/03 is to cover the service provided by the effluent analysis laboratory of Chemistry Support Services (CSS) for the analysis of samples arising from the requirements of the Discharge Technical Implementation Documents (TID) and for all other samples sent to the laboratory. To that effect CSS/QP/03 addresses topics such as:

- Management and responsibilities.
- Qualifications and experience.
- Analytical methods and standards of analysis.
- Calibration and quality control.
- Sampling and storage of samples.
- Authorisation of analysis and reporting of results.

[6] More information can be found under http://www.ukas.org

- Records and electronic media.
- Audit and review.
- Training of staff.
- Measurement audits and inter-laboratory comparisons.

At the same time CSS/QP/03 lists all ensuing quality controlled working/operating instructions and also provides references to other quality assurance plans where relevant.

7.9.2. Verification activities

The verification team visited the sample preparation and measurement areas of the laboratory where it checked:

- The presence of 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 a randomly chosen historical sample in order to verify the data transmission chain between initial measurement of the sample and final reporting to the competent authority.

7.9.3. Verification findings

During the course of the visit the verification team confirmed the existence and functionality of sample measurement devices as well as the implementation of measurement techniques as stated in the TIDs and described in the related quality assurance documents.

The quality assured working instructions cover sample taking and preparation, analytical methodology, statistical tests to verify the plausibility of results as well as subsequent actions in case of divergence and, finally, training of staff. Procedure revisions are well documented, provide traceability and their distribution is clearly defined.

Randomly chosen laboratory source documents were audited to verify the implementation of related working instructions: this verification activity did not yield any shortcomings.

The team noted that a general database system is under construction that would ease the reporting tasks that are currently spreadsheet-based. This development is steered by the Safety and Environment Group.

> *The verification activities revealed that sample management, analytical procedures and record keeping do no depart from standards. Data management is consistent and adequate archiving of results obtained is in place. Calibration and maintenance of analytical equipment is adequately documented and well organised.*
>
> Also:
>
> *The verification team, in the framework of general quality assurance and control, endorses the project of replacing the current spreadsheet-based reporting system by an integrated database that would reduce the number of data input operations.*

7.10. Quality assurance and control

7.10.1. Introduction

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

"Subsequent to UKAEA notifying SEPA that, for the period 1996-1998, gaseous radioactivity discharge data (FCA main stack) had been under-recorded and under-reported, SEPA served an Enforcement Notice requesting that gaseous discharge data records be validated for the period 1993-1998 and, where appropriate, corrected. The under-recording and under-reporting only affected a limited number of radionuclides and did not lead to any breaches of authorised discharge levels. The team satisfactorily verified the status of implementation of the Enforcement Notice by checking the amended procedures and verifying the validity of the amended gaseous discharge data".

This finding led to the following recommendation:

"The (verification) team recommends SEPA to ensure that procedures are put in place to allow prompt detection of failures in quality assurance and control programmes."

In its response to the verification findings the Scottish Executive stated:

"Quality assurance and control programmes for monitoring discharges according to the requirements of the Radioactive Substances Act authorisations are a key focus of the planned SEPA inspections".

7.10.2. Verification findings

Current Certificates of Authorisation for the disposal of gaseous and liquid radioactive waste came into force on 16 August 1999, after the verification visit to Dounreay (March 1999). These authorisations and the associated Technical Implementation Documents require the use of quality assurance procedures to the ISO9001 standard.

SEPA furthermore encouraged UKAEA to obtain UKAS accreditation for its laboratories.

In general, with respect to the statutory control of airborne discharges, the verification team noted:

(1) Since the Article 35 verification visit in 1999 the statutory sampling equipment for airborne discharges has been improved to provide more robust and reliable systems.

(2) The new systems, in their design, comply with the Environment Agency Guidance Note M11 [(7)], titled "Monitoring of Radioactive Releases to Atmosphere from Nuclear Facilities".

(3) The new systems, that are similar for nearly all stacks on site, have been designed to provide:

- Isokinetic sampling of particulate.
- Dual pumps with automatic change over.
- Continuous flow measurement recording of sample flow.
- Total sample volume measurement.
- Continuous flow measurement recording of duct flow.
- Total duct volume measurement.
- Remote fault alert at a continuously manned station.

(4) Maintenance of these systems is centrally controlled by the site-wide maintenance department. A database is in place that automatically informs maintenance staff about those devices that are scheduled for maintenance.

(5) All quality assured documents are centrally controlled by the site-wide document control department.

7 http://www.environment-agency.gov.uk/commondata/acrobat/m11.pdf

The verification activities revealed, in comparison to the prevailing situation in 1999, that quality assurance has been significantly improved. Similar statutory sampling equipment for all discharge points, centralised documentation and maintenance control and the obtention of UKAS accreditation for the laboratories have been important factors in achieving this.

8. VERIFICATION ACTIVITIES - ENVIRONMENTAL MONITORING

8.1. Environmental monitoring by the UKAEA

8.1.1. Introduction

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

8.2.1.1 With respect to high volume air samplers

"At Shebster the high volume air sampler (HVAS) was not in operation when the verification team arrived, its power supply being switched off. […]"

This finding led to the following recommendation:

"The verification team recommends UKAEA to fit its environmental monitoring stations with guaranteed power supply systems and to implement a remote automatic warning system in case of failure".

In its response to the verification findings the Scottish Executive stated:

"UKAEA has now fitted the high volume air samplers with simple devices to give operating hours. These are checked weekly and all monitors have been shown to operate satisfactorily. The provision of a monitor to confirm operating periods is considered to be a worthwhile improvement".

8.2.1.2 With respect to available quantities of marine samples

"The verification team noted that the amount of samples collected with respect to lobster, salmon and whelks for the year 1998 had been insufficient, thus affecting the availability of Sr-90 data".

This finding led to the following recommendation:

"The verification team recommends that in future either additional samples be taken until such quantities are gathered which allow a full implementation of the environmental monitoring programme or, where a sample type is not available in sufficient quantity, that this be reported and documented, thus enabling SEPA to take appropriate measures".

In its response to the verification findings the Scottish Executive stated:

"[…] It should be noted that on occasion UKAEA had found it difficult to obtain sufficient samples but that this reflected the scarcity of those species rather than the lack of effort to obtain them. UKAEA will advise SEPA on those occasions when sufficient samples cannot be obtained. […]".

The verification team, being satisfied with the response by the competent authorities, closed this topic.

8.1.2. Verification activities

The verification team focussed its verification activity on the improvements made with respect to UKAEA high volume air samplers (HVAS) as well as the sampling procedures for environmental samples in general.

8.1.3. Verification findings

8.2.3.1 <u>UKAEA high volume air samplers</u>

The team visited the HVAS situated at the Reay Golf Course. This is one of six such systems currently in place around the Dounreay site.

The team noted that:

(1) The air sampling pump draws approximately 2m³/minute through a polystyrene filter in a re-loadable filter cartridge.
(2) No back-up power supply is available.
(3) An alarming system in case of power supply failure or pump failure is not present.
(4) Since 1999, a device logging the operating hours has been added to the system.
(5) In case of a power supply failures, these will be reflected in the number of operating hours recorded.
(6) The HVAS systems are inspected weekly. If any, operational failures will be detected at this stage.

The team was told that UKAEA are aware that the modification it brought to the HVAS system is not fully satisfactory. Therefore UKAEA developed a 'new generation' HVAS system: this system that is still in its testing phase was demonstrated to the verification team.

With respect to the 'new generation' HVAS the team noted that:

(7) The system is modern in its design.
(8) The system incorporates an airflow meter in a laminar flow tube.
(9) The system is equipped with a maintenance free pump (turbine type).
(10) Technically, the system could provide on-line access to operational parameters.

The verification team endorses the efforts made by UKAEA to develop an improved HVAS system for its statutory environmental monitoring programme.

The verification team suggests that SEPA considers requiring the replacement of the existing HVAS with the 'new generation' device when the latter has proven its operability.

At the same time it is suggested that if the new HVAS would become the standard equipment, its locations be fenced off so as to ensure its physical integrity.

8.2.3.2 <u>Sampling procedures</u>

The team noted that:

(1) Environmental sampling is outsourced to a contractor.
(2) The sampling programme is given to the contractor on a yearly basis. This programme specifies, in accordance with requirements in the authorisation and TIDs, the media to be sampled as well as sampling locations and date/time of the sampling (for a summary of the statutory sampling programme, see Appendix 6). At the same time the contractor receives the

whole set of quality assured sampling instructions he has to abide by. These instructions ensure that sample collection and instrumentation usage is carried out in a defined way. The verification team received a copy of working instructions EPD/OI/4.4 “collection of rootmat and soil samples” and EPD/OI/4.27 “collection of airborne dust using high volume air samplers”.

(3) The contractor delivers the samples taken once a week. Delivered samples are clearly labelled and are systematically accompanied by a sample taking record. Such sample taking records are integral part of the working instruction.

(4) The UKAEA Environment Group controls whether the contractor takes and delivers the samples in accordance with the sampling programme. The contractor has to report and justify any departure from the programme. If any, these justifications must be delivered within the week after the scheduled sampling activity.

The relationship between UKAEA and its contractor are duly formalised.

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

8.2. Environmental laboratory (UKAEA)

8.2.1. Introduction

The laboratory is UKAS accredited [(8)] according to ISO 17025 for most of the analytical methodologies applicable to the statutory environmental samples.

Quality assurance and control is managed through written documentation, of which CSS/QP/01 (quality plan for environmental analysis) is the cornerstone. The general purpose and scope of such quality assurance plans are summarised in section 7.9.1 above.

8.2.2. Verification activities

The verification team visited the sample preparation and measurement areas of the laboratory where it checked:

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

8.2.3. Verification findings

During the course of the visit the verification team confirmed the existence and functionality of sample measurement devices as well as the implementation of measurement techniques as stated in the TIDs and described in the related quality assurance documents.

The quality assured working instructions cover sample taking and preparation, analytical methodology, statistical tests to verify the plausibility of results as well as subsequent actions in case of divergence and, finally, training of staff. Procedure revisions are well documented, provide traceability and their distribution is clearly defined.

The team also noted that:

[8] More information can be found under http://www.ukas.org

(1) All sample and analysis data are collected in the form of spreadsheets. The results are then transferred into a working spreadsheet for evaluation (trend analysis etc.), quality control and validation. The working spreadsheet provides writing access to two designated members of staff only. The latter are also responsible for extracting and forwarding the validated data (formatted according to the regulatory requirements) via e-mail to the Environment Group. The Environment Group then converts the data into the format for regulatory reporting and then submits these to SEPA on a monthly basis. Responsibilities and chain of custody are clearly defined.
(2) The working spreadsheet automatically highlights any results that are above notification level. The in-built checks on various regulatory reporting/notification constraints are an additional layer of quality assurance and control.

The verification activities revealed that sample management, analytical procedures and record keeping do no depart from standards. Data management is consistent and adequate archiving of results obtained is in place. Calibration and maintenance of analytical equipment is adequately documented and well organised.

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

8.3. Environmental monitoring by SEPA

8.3.1. Introduction

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

"Since the 1993 art.35 verification, the monitoring programme has not been modified except for the discontinuation of drycloth filter monitoring decided in 1997. SEPA is currently evaluating whether medium velocity air samplers should replace drycloth filters".

This finding led to the following recommendation:

"The verification team finds that the installation of independent medium velocity air samplers would be an advantage and recommends that SEPA gives consideration to this".

In its response to the verification findings the Scottish Executive stated:

"SEPA invited tenders for a revised programme for the monitoring of radioactivity in the environment. The tender was let to the NRPB with effect from 1 April 2000. It includes the requirement to supply, deploy, maintain and manage a network of medium volume air samplers around a number of nuclear sites in Scotland including Dounreay. The requirement for Dounreay is for three medium volume air samplers - one at each of three locations".

8.3.2. Verification activities

The verification team visited the SEPA air sampler located at the Balmore Animal Welfare Centre, east of the Dounreay site. The appropriateness and functionality of the device were checked.

8.3.3. Verification findings

The verification team noted that:

(1) The device is operated and maintained by NRPB (as contractor to SEPA).
(2) The device is secured in a locked cubicle and labelled sampler number 3.

(3) The device is a MUNRO type L60iF Portable air Sampler that nominally samples 60 dm^3/minute (with filter) and is equipped with a flow gauge.
(4) The device is also equipped with a data logger that registers elapsed time and flow rate (both parameters are used to calculate the collected sample volume). The data logger has a battery back-up in case of power failure.
(5) The filter (60 mm diameter) of the device is exchanged on a monthly basis. At the same time the system is serviced. Service and filter exchange interval is undertaken every calendar month. The period between servicing will not normally exceed 35 calendar days.
(6) A full maintenance and functionality testing of the device is performed once a year. Tags were present that indicated that the last maintenance was performed in May 2004 and that the next was scheduled for May 2005.
(7) The sampling pump itself has no power supply back-up. This may lead to a sampling interruption of 35 days at most (maximum time between servicing) if a complete loss of power occurs. In case of an intermittent power failure the system automatically starts up when power is restored. NRPB, when performing the servicing tour, always takes along three spare pumps.
(8) The device is equipped with an audible (and visual) flow loss alarm. Such an alarm may be heard by the landowner where the sampler is located. The team was told that an agreement exists between the landowner and NRPB that should such an alarm occur, the landowner would inform NRPB.

The verification team considers the sampling equipment to be adequate. As there are three samplers monitoring the Dounreay environment, the temporary loss of functionality of one of them does not significantly affect SEPA monitoring capabilities.

The verification team considers that the recommendation that was made in 1999 with respect to the possible installation of medium velocity air samplers has been implemented to satisfaction.

8.3.4. Further observations

8.3.4.1 <u>Introduction</u>

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

"The audit of the environmental data management structure at the SEPA Head Office revealed that there is room for improvement".

This finding led to the following recommendation:

"The verification team recommends SEPA to integrate the historical set of environmental data it inherited from the Scottish Office into its present electronic data management tool. The present split between the two sets of data is not satisfactory".

In its response to the verification findings the Scottish Executive stated:

"SEPA agrees that there is a need to integrate the historic environmental data inherited from the Scottish Office with current environmental data. Therefore SEPA is currently pursuing the implementation of a project to develop a single database to integrate both the inherited historic data and the current data".

8.3.4.2 <u>Verification activities and findings</u>

SEPA demonstrated that they implemented a database for environmental monitoring data.

The verification team noted that:

(1) The database includes the historic data SEPA inherited from the Scottish Office.
(2) A management tool is incorporated that allows easy control of the completeness and timeliness of the sampling programme and corresponding analytical results.
(3) Included is a reporting tool that creates tables for the annual Radioactivity in Food and the Environment (RIFE) reports.
(4) SEPA might in the future further develop the database to allow public access to it.

9. PARTICLES IN THE MARINE ENVIRONMENT

9.1. Introduction

Sand-sized fragments of irradiated nuclear fuel probably originating from reprocessing operations at Dounreay in the 1960s have been discovered intermittently since 1983 on the Dounreay foreshore. Survey work by UKAEA (summer 1997) revealed that the contamination of the seabed near Dounreay by such particles was much more extensive than previously thought. Subsequently the Scottish Executive (then Scottish Office), on 29 October 1997, imposed a fishing restriction under the 1985 Food and Environment Protection Act (FEPA) in an area of 2km radius around the end of the Dounreay site outfall pipe.

Particles are also regularly detected and removed from Sandside Bay (west of the Dounreay site). It should however be noted that since 1984, no such particles were detected at any other local beach.

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC stated that:

- "*The verification team endorses the recommendations made in the 1998 SEPA/NRPB report on radioactive particles in the Dounreay marine environment as well as UKAEA's intended investigative programme to establish definitively the origin of the particles".*

  "A clear demonstration of the source(s) of particles and their likely future movement and eventual dispersion is needed to provide a reliable estimate of the risk to the public at Dounreay and the surrounding areas. The Commission would appreciate being kept informed about further investigation results and envisaged remedial actions".

- *"Reassurance monitoring of beaches must continue and be expanded where members of the public potentially may encounter radioactive particles. […]".*

  "The verification team recommends the extensive use of the vehicle-mounted beach monitoring system which, in conjunction with the frequency and extent of beach monitoring SEPA is requesting in the new draft Authorisations, will ensure an appropriate monitoring programme of public beaches around Dounreay".

In its response to the verification findings the Scottish Executive stated, respectively:

- *"UKAEA reports that 1999 saw a considerable amount of work on the seabed aimed at identifying the extent of the particles, their concentration in the sediments and how they move on the seabed. The measurements are now being analysed in detail. The Commission will be kept informed of progress in this area".*
- *"UKAEA confirms that additional beach monitoring using multi-detector vehicle mounted systems was introduced in the summer of 1999. This monitoring, together with the continuing strandline monitoring programme, has resulted in the detection and removal of eight radioactive particles from the beach accessible to the public at Sandside between July 1999 and current date (May 2000). All eight particles were at the low end of the activity spectrum found in the enclosed Dounreay foreshore and seabed".*

9.2. Present situation

The fishing restrictions under the Food and Environment Protection Act 1985 (FEPA 85) are still in force.

Since 1999, further radioactive fragments were recovered near Dounreay (Appendix 7). For instance, during 2003, three radioactive fragments were recovered from the site foreshore, 24 from Sandside beach and 56 from the seabed near to the Dounreay site. The Cs-137 activity measured in the fragments recovered from Sandside beach ranged between 8.4 kBq and 280 kBq. It should be noted that no such fragments were detected at any other local beach.

9.2.1. Monitoring of public beaches

Under the current UKAEA liquid discharge authorisation, the Technical Implementation Document (TID) requires the detection of fragments with Cs-137 activities of at least 100 kBq from the surface 10 cm of beach sand. The regulatory requirement on area coverage is to monitor a minimum of 250000 m^2 of Sandside beach per month. No area coverage requirement is specified for any other beaches. The extent of monitoring is from mean high water springs to neap low water or as reasonably practicable to low water springs. Other local beaches must be monitored at a reduced frequency but to the same detection sensitivity (Appendices 7 and 8).

Since some of the smaller beaches and some areas of the larger beaches, including Sandside, are not accessible by vehicle, a portable monitoring system with similar measurement capability as the vehicular system is presently used.

The first particle-monitoring multi-detector vehicle, Groundhog™ (GH), commenced service in 1999. This system detected 17 particles from July 1999 to April 2002.

An improved monitoring vehicle, Groundhog Evolution™ (GE), commenced service in November 2002, when the access to Sandside beach was reinstated (Appendix 8). This system has detected 31 particles between November 2002 and 30 April 2004, at which date the landowner rescinded an access agreement covering Sandside beach.

The vehicle-mounted GE provides better area coverage rate and is more sensitive (5 sodium iodide detectors of 75x400 mm) than the earlier GH: GE has detected particles of average activity 52 kBq Cs-137, while GH has detected particles of average activity 93 kBq Cs-137.

9.2.2. Off-shore surveys

9.2.2.1 Surveys by divers.

Particles were first recovered from the marine environment off Dounreay in 1997. Between 1997 and 1999, annual underwater surveys by divers resulted in a total of 138 particles being recovered. The divers use a hand-held plastic scintillation counter. Within the same period, a detector array was towed over selected areas of the seabed outwith effective diver working depth, enabling a statistical assessment of potential particle populations to be derived. The findings of these surveys is reported in "Dounreay Particles Offshore Particle Populations" [EPTG(00)P07 Rev 2 August 2000].

Throughout the summer seasons of 2000 to 2002, divers continued to survey, identify and recover particles from the seabed off Dounreay. The focus of the surveying was revised after 1999. In 2000, 7 specific areas of the seabed, (each of area 2500 m^2) were identified and surveyed more systematically than the earlier surveys such that confidence was obtained that the defined area had been fully surveyed and that all identified particles has been recovered. This work was followed in subsequent years by repeat surveys of the defined areas, with all particles being recovered, giving evidence of the rates of re-population of the areas and insight into potential particle transport and distribution mechanisms. These areas are defined as the re-population areas. In addition, surveys of areas of specific interest, as on the rock platform close inshore to Dounreay and in 5 areas designated as "remote" from the Dounreay site (stretching from Strathy to east of Brims Ness) were also completed. Through 2000 to 2002 a further 579 particles were recovered. A re-assessment of the distribution of particles in the off-shore environment incorporating the particle findings from 2000 - 2002 is reported in "Offshore Particle Populations – A Review of Diving Surveys 2000 – 2002." [EPD(02)P86 Jan 2003].

Subsequent to the 2002 surveys, the programme of repeat surveys of the re-population areas has continued, with new areas being introduced in 2004. On the basis of risk, the time spent diving in recent years has been reduced from that expended in 2002. However a further 117 particles were recovered in the period 2003 and 2004.

9.2.2.2 Surveys by detectors (without divers).

In late 2003, a limited programme of trials using an underwater gamma spectrometry system for the detection of particles without diver intervention was carried out off Dounreay. This involved putting the detector on the seabed as a number of spot drops, then the detector was moved over the seabed, taking typically 1-minute spectra at each position. Some diver support for this operation is required to enable recovery of identified particles. The results of these trials are reported in "Field trials of a marinised sodium iodide detector off Dounreay in September 2003" [EPD(03)P106 Jan 2004].

Building on the experience derived from this work, the scope of the trials has been extended, with a larger sodium iodide detector than used previously being mounted on a custom built remotely operated vehicle. This could provide a factor of up to 10 faster rate of particle mapping than using divers, but without particle retrieval. A period of 30 days mapping of the seabed is programmed to commence in September 2004, which will be fully reported in early 2005.

9.2.3. Underlying support programmes

A number of working groups, studies and modelling programmes are currently in place and/or undertaken to provide additional scientific insight in the issue of the radioactive particles. These also aim at developing improved technical means of surveying as well as further assessing the potential health effects linked to the presence of the particles.

These actions are listed and summarised in Appendix 9 to this report.

9.3. Verification activities and findings

9.3.1. Beach surveys

The verification team witnessed, in accordance with the programme of activities, a demonstration of the Groundhog Evolution motorised survey system. This demonstration took place at Thurso beach.

The verification team noted that Groundhog Evolution can provide more adequate surveillance capabilities than the former system (number of detectors, higher sensitivity, improved geometry, enhanced mobility, bigger area covered per unit time). The detector signals are linked with satellite positioning technology data (GPS) thus allowing a precise mapping of the area monitored.

> *The verification team welcomes the technical improvements achieved with Groundhog Evolution, allowing enhanced survey capability and detection efficiency. It is suggested that SEPA regularly evaluate the feasibility and necessity of imposing an even more stringent target performance on the beach monitoring systems.*

The verification team also learned that the owner of Sandside beach still refuses access to the surveying teams. Sandside beach is the only publicly accessible beach where radioactive particles have been found until now.

The verification team suggests that the competent authorities reach an agreement with the owner of Sandside beach so as to resume local survey activities at regular intervals. The programme of detecting and subsequent prompt removal of particles of radiological significance should not be interrupted at this beach.

9.3.2. Marine surveys

The verification was shown a video demonstration of the off-shore monitoring device that is currently being tested.

The verification team endorses the efforts made to develop further technical means to fully determine the extent of the contamination (characterisation, population, distribution and dynamics) of the local marine environment with particles of radiological significance.

9.3.3. Further remarks

The verification team also considers that both recommendations that were formulated in 1999 have been given due attention:

- UKAEA continues to run investigative programmes to establish definitively the origin of the particles and their marine dynamics.
- Monitoring of beaches continues and survey techniques and hardware have been improved.
- UKAEA and SEPA continue to provide information on progress made. Information is publicly accessible under:
    - http://www.sepa.org.uk/radioactivity/dpag/
    - http://www.ukaea.org.uk/dounreay/particles.htm
    - http://www.rwenukem.co.uk/products_and_services/products/groundhog/

However:

The Commission would appreciate it being kept informed about any further investigation results and envisaged remedial actions with respect to particles of radiological significance in the marine environment around Dounreay, both on-shore and off-shore.

10. THE DOUNREAY SHAFT

10.1. Introduction

The Dounreay Shaft was originally excavated in 1956 as a route for removing spoil from the construction of the liquid effluent discharge tunnel to sea. The Shaft is 4.6 m in diameter and 65 m deep. At its base there is a 33 m long connecting tunnel between the Shaft and the main tunnel. The main tunnel contains the pipes used to discharge the trade and low level radioactive effluent from the site. There is a 2.4 m thick concrete plug in the connecting tunnel 20 m away from the Shaft (see Appendix 10, figures 1 and 2).

In 1959, the Scottish Office authorized the Shaft to be used as a disposal facility for solid radioactive waste.

UKAEA used the Shaft for disposal of solid waste between 1959 and 1971 when the Wet Silo came into service as an ILW store. The Shaft was used until 1977 for items that were too large for the Wet Silo when an explosion in the Shaft led to cessation of input of material (see Appendix 10, figure 3). By 1997 approximately 700 to 750 m^3 of radioactive waste accumulated in the Shaft.

In its March 1999 verification findings transmitted to the Scottish competent authorities, the EC recommended that:

"The verification team recommends that the boreholes (that are part of the hydrogeological survey undertaken around the Shaft) be used for environmental monitoring purposes insofar as frequent analysis of water samples extracted from these boreholes may monitor any activity escaping from the Shaft to the environment. The Commission would appreciate receiving a copy of the final report on these hydrogeological investigations and being kept informed about future developments".

In its response to the verification findings the Scottish Executive stated:

"UKAEA intends that the boreholes around the Shaft, as well as other boreholes in different areas of the site, be used as part of the Dounreay site overall environmental monitoring programme. The Commission will be kept informed on progress in this area".

10.2. Verification activities and findings

In accordance with the programme of activities agreed with the competent authorities, the verification team was extensively briefed on progress made since 1999. Presentations were given that explained the current situation and future prospects with regard to the waste retrieval from and eventual decommissioning of the Shaft. The information received is summarised in section 10.2.1 below.

10.2.1. Present situation and future developments

In 1998, the UKAEA decided that with the advances in technology, retrievability of the waste and decommissioning of the shaft would be feasible. Waste retrieval and decommissioning, however, cannot be achieved without controlling groundwater flow into and out of the shaft. UKAEA decided to use grout to isolate the shaft from the environment.

Under the plan, a 10-m-wide band of rock around the shaft will be sealed by injecting grout into the fissures to form a deep containment barrier that will stop the flow of groundwater into the shaft. Most of the groundwater entering the shaft is pumped out, checked, and discharged to sea via D1211 (now LLLETP). A small amount of groundwater is known to have flowed through the shaft since the 1950s, transporting radioactivity that has contaminated the rock on the seaward side. Hydraulic isolation of the shaft will stop this phenomenon and will reduce the amount of activity that needs to be discharged. It will also eliminate any lingering doubts that the shaft could be a continuing source of particles found in the marine environment near Dounreay. The grout curtain will envelop the shaft, stabilizing its environment for waste retrieval and eliminate the risk of a major leakage as an environmental hazard.

A series of exploratory boreholes and grouting trials are scheduled over the next 12 months before work to isolate the shaft begins early in 2006.

Subject to appropriate regulatory approvals, isolating the shaft with a curtain of grout will require 350-400 boreholes to be drilled to depths of 80 metres in an oval ring around the shaft. The grout would be injected in the boreholes and forced into the fissures in the rock to create a solid 360 degrees curtain. The grouting operation is expected to take between two and four years to complete.

The program of work includes the reinforcement of a plug at the base of the shaft with high-strength concrete to ensure that it can withstand the changes in water pressure that are expected to occur when waste retrieval begins.

10.2.2. Findings

The verification team also considers that the recommendations that were formulated in 1999 have been given due attention.

However:

> *The Commission would appreciate it being kept informed about progress made with respect to the isolation project of the Dounreay Shaft and any further actions that may be undertaken to remove the waste that is contained within the Shaft.*

11. CONCLUSIONS

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

The information provided and the outcome of the verification activities led to the following observations:

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

(2) The follow-up of the recommendations made in 1999 revealed that:

- The standards of quality assurance and control have been improved.
- Airborne discharge sampling equipment has been standardised and modernised.
- The Low Level Liquid Effluent Treatment Plant has become fully operational. This modern plant allows an improved control over liquid effluent discharges.
- Progress has been made with respect to scientific knowledge about the particles of radiological significance that are present in the marine environment (characterisation, population, distribution, marine dynamics).
- Progress has been made with respect to the Shaft: the Shaft Isolation Project is likely to go ahead in 2005. Isolating the Shaft from its environment is a prerequisite before emptying of the Shaft can commence.
- Progress has been made with respect to beach monitoring for particles of radiological significance (enhanced detection efficiency and survey capability).

(3) Sandside beach is, to this date, the only public beach in the area where particles of radiological significance have been detected and removed. It is regrettable that the competent authorities and the owner of Sandside beach cannot find an agreement that would allow continued full-scale monitoring of this public beach.

(4) A small number of topical suggestions are formulated. These aim at improving some aspects of the environmental surveillance around the Dounreay site. They do not discredit the fact that environmental monitoring around the Dounreay site is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(5) The verification findings and ensuing recommendations are compiled in the 'Main Findings' document that is addressed to the United Kingdom competent authority through the United Kingdom Permanent Representative to the European Union.

(6) The present Technical Report is to be enclosed with the Main Findings.

APPENDIX 1

The verification programme – summary overview

Tuesday 28 September

Morning

- Opening meeting with presentations:
  - -- General introduction (SE)
  - -- Review of 1999 EC recommendations (SEPA)
  - -- Progress report on particles in the marine environment (UKAEA)
  - -- Progress report on the waste shaft (UKAEA)
- Monitoring / sampling provisions for airborne discharges from WRACS

Afternoon

- Continuous off-site air sampler at the Control Tower location (UKAEA)
- Continuous off-site air sampler at the village of Reay (UKAEA)
- Continuous off-site air sampler at Balmore (SEPA)
- Beach monitoring at Thurso (Groundhog device)

Wednesday 29 September

Morning

- Monitoring / sampling provisions for liquid discharges from LLLETP
- Monitoring / sampling provisions for airborne discharges from SDP
- Monitoring / sampling provisions for airborne discharges from FCA (main stack)
- Monitoring / sampling provisions for airborne discharges from D1200 (minor stack)
- Continuous alpha monitoring at the Marshall Laboratories

Afternoon

- Effluent laboratories
- Environmental laboratories

Thursday 30 September

Morning

- Environmental programmes department:
  - -- calculation of discharges
  - -- assessment of environmental monitoring results
  - -- reporting to SEPA
- Closing meeting

APPENDIX 2

References & Documentation

Scottish Environment Protection Agency

1 Radioactivity in Food and the Environment, 2003 (RIFE-9) – issued by EA + FSA + SEPA
2 Environmental Monitoring Programme for Radioactivity.
3 Certificate of Authorisation for the disposal of radioactive waste (gaseous) – RSA/N/50010/99.
4 Certificate of Authorisation for the disposal of radioactive waste (liquid) – RSA/N/50011/99.
5 Certificate of Authorisation for the disposal of radioactive waste (solid) – RSA/N/50012/99.
6 Notice of variation of Authorisation – RSA/N/V01/50010/99.
7 Notice of variation of Authorisation – RSA/N/V01/50012/99.
8 Technical Implementation Document (gaseous radioactive waste discharges) – May 2004.
9 Technical Implementation Document (liquid radioactive waste disposals) – July 2004.
10 Technical Implementation Document (solid radioactive waste disposals) – September 2001.
11 Enforcement Notice RSA/EN/N/50007/02 of 30/01/2002
12 Enforcement Notice RSA/EN/N/50008/03 of 18/06/2003

UKAEA

13 Sampling equipment for the monitoring of discharge of gaseous and liquid radioactive waste.
14 Improvements to high volume air samplers.
15 Summary of the statutory marine monitoring programme.
16 Sampling and survey locations associated with the statutory marine monitoring programme.
17 Summary of the statutory terrestrial monitoring programme.
18 Sampling and survey locations associated with the statutory terrestrial monitoring programme.
19 Statutory High Volume Air Sampler and Deposition Monitoring Locations (map).
20 Quality assurance and control programmes (environmental).
21 D1211 & D3000 Sampling Plan (liquid), reference OG(03)P30 of 15/10/2003.
22 D3000 Sampling Plan (gaseous) issue 1, reference OG(04)P17 of 14/09/2004.
23 Chemistry Support Services Quality Plan CSS/QP/01 (issue 10) for Environmental Analysis.
24 Chemistry Support Services Quality Plan CSS/QP/03 (issue 11) for Discharge Analysis.
25 Chemistry Support Services Quality Plan CSS/QP/06 (issue 11) for Radiometric Counting Services Analysis Laboratories.
26 Chemistry Support Services Quality Plan CSS/QP/14 (issue 4) for Emissions, Mass Spectrometry and X-Ray Diffractometry.
27 Chemistry Support Services Quality Plan CSS/QP/21 (issue 8), Analytical Production Section Standards & Controls Laboratory Operations.
28 Overview of the investigative progress made and remedial actions undertaken in relation to the Dounreay particles.
29 Technical drawing SDP/CRP stack sampling system – panel P95019.
30 Technical drawing SDP/CRP stack sampling system – position of sample nozzles.
31 Technical drawing SDP/CRP stack sampling system – part of DRG C9968-01561-001-V04.
32 Technical drawing 1Z192382 (issue D) – D2670 duct sampling enclosures.
33 Technical drawing 1Z196523 (issue B) – minor stack sampling equipment (particulate).
34 Diagram: D1200 stack, cross section at sampling point.
35 CSS D1200 statutory stack and duct particulate analysis log.
CSS radiometric counting analysis sample log.
36 Technical drawing 0Z217918 (issue B) – D1213 stack sampling enclosure and equipment.
37 Technical drawing 0Z217764 (issue B) – D1213 stack sampling arrangement (tritium).
38 Technical drawing 0Z218148 (issue B) – D1213 stack sampling probe (tritium).
39 Technical drawing 0Z218165 (issue B) – D1213 stack sampling probe (particulate).
40 Technical drawing 0Z192388 (issue D) – D8570 duct sampling enclosure.
41 Technical drawing 1H950059-1 (issue 12) – alpha/beta monitor AB96+.
42 D1293 (Glasdon Enclosure) asset information.
43 Manual for the Vortex Velocity flowmeters, series VP7000 and VF588.
44 Operation instructions for ultrasonic Vortex gas flow transmitters.
45 Harwell 3280 stack sampler at D2670 – characterisation report AEAT-5889/issue2/A2.11.

46 Environmental Programmes Department Operating Instruction EPD/OI/4.4 (issue 3 of June 2004): collection of rootmat and soil samples.
47 Environmental Programmes Department Operating Instruction EPD/OI/4.27 (issue 3 of June 2004): collection of airborne dust using high volume air samplers.
48 Groundhog Evolution – specifications.

Other sources consulted

- http://www.sepa.org.uk
- http://www.scotland.gov.uk
- http://www.ukaea.org.uk/dounreay/index.htm
- http://www.nrpb.org
- http://www.foodstandards.gov.uk

APPENDIX 3

SEPA – Environmental Monitoring Programme

Introduction.

SEPA's environmental monitoring programme around Dounreay has been designed to fulfil the following functions:

- Provide data for use in retrospective critical group dose assessments.
- Operator check monitoring.
- Provide a baseline data set for use in the event of accidental release.

1. Surveillance of liquid discharges (marine monitoring).

The activity concentrations of radionuclides in the environment originating from liquid discharges are determined by undertaking a comprehensive marine monitoring programme. Sampling locations and types of sample collected are chosen by considering local environmental conditions and regular habit surveys of the local population. Habit surveys are undertaken at least every 5 years.

The marine monitoring programme can be subdivided into the following broad sample types.

1.1 Measurement of dose rates over intertidal sediment

Gamma dose rate measurements are currently taken at 15 locations in the vicinity of Dounreay site as detailed in table 1. Measurements are made on annual basis except at Sandside Bay and Oigins Geo, these two locations are thought to be the most likely to show any elevated levels of radionuclides due to local environmental conditions and their geographical position in relation to the discharge pipeline. At these sites measurements are made on a more frequent basis and samples of intertidal sediment are also collected for further radiochemical analysis.

Beta dose rate measurements and gamma strandline measurements are also made at three locations along the coast, Sandside Bay, Oigins Geo and Brims Ness. These locations represent a point west of the liquid discharge point, the discharge point itself and east of the discharge point respectively. These measurements do provide general surveillance but are primarily for public reassurance.

To provide further information on the level of radionuclides in intertidal sediment, samples are collected from three locations on which further analysis is undertaken (table 2). Intertidal sediment is only collected from Oigins Geo, when spume is not available.

Table 1: Location and frequency of dose rate measurements undertaken in the vicinity of Dounreay.

Location	Gamma dose rate	Gamma strandline	Beta dose rate
Sandside Bay - over winkle bed	Quarterly	-	-
Sandside Bay - over sand	Annually	Annually	Quarterly
Sandside Bay - over gill nets	Annually	-	-
Oigins Geo	Quarterly	Annually	Quarterly
Castletown Harbour	Annually	-	-
Melvich - over saltmarsh	Annually	-	-
Melvich - over sand	Annually	-	-
Strathy Sands	Annually	-	-
Thurso riverbank	Annually	-	-
Achreregan Hill	Annually	-	-
Strathy Park	Annually	-	-
Archvadarsal	Annually	-	-
Thurso Park	Annually	-	-
Borrowston Mains	Annually	-	-

Hallam Farm	Annually	-	-
Brims Ness	-	Annually	Quarterly
Kinlochbervie	-	-	-
Burwick Pier	-	-	-
Rennibster, Orkney	-	-	-

Table 2: Sampling location of sediment samples and analyses undertaken.

Location	Sampling frequency	Determinands
Sandside Bay	Annually	Gamma emitters, Am-241*, alpha emitting plutonium isotopes*
Oigins Geo	Annually	Gamma emitters, Am-241*, alpha emitting plutonium isotopes*
Rennibster, Orkney	Annually	Gamma emitters

* Analysis is undertaken on an annual bulk sample.

1.2 Seawater samples

Seawater samples are collected quarterly from Sandside Bay. Gamma analysis and determination of the total tritium content is undertaken on each sample.

1.3 Seaweed samples

Seaweed samples are an excellent environmental indicator as they can readily accumulate certain radionuclides. Seaweed can also be used as a soil conditioner or livestock fodder; it is therefore prudent to have information on the radionuclide content of seaweed. For these reasons seaweed samples are included in SEPA's monitoring programme. Seaweed samples are taken from 4 locations, Sandside Bay, Brims Ness, Kinlochbervie and Burwick Pier. All samples are analysed for gamma emitting nuclides, additionally the Sandside Bay samples have total alpha and total beta measurements undertaken on them.

1.4 Seafood samples

The remainder of the marine monitoring programme concerns the analysis of seafood samples. Table 3 summarises the seafood analysed the location that it is collected from and the radiochemical analyses carried out. Seafood samples are included in the monitoring programme primarily to ensure that radiation exposure to the public is within acceptable limits. For this reason the design of the monitoring programme is heavily influenced by the findings of habit survey reports and what seafood is available in the area.

Table 3: Seafood samples and the analyses undertaken on them collected from the vicinity of Dounreay. AB indicates that the analysis is undertaken on an annual bulk sample.

Seafood samples	Collection frequency	Gamma analysis	Alpha (Am, Pu)	Tc-99	Sr-90	C-14
Sandside Bay - Winkles	Quarterly	yes	AB	AB	AB	-
Strathy - Crab	Quarterly	yes	AB	-	-	-
Kinlochbervie - Crab	Quarterly	yes	AB	AB	-	-
Melvich - Crab	Quarterly	yes	AB	AB	-	-
Echnaloch Bay, Orkney - Mussels	Quarterly	yes	AB	AB	-	-
PLZ - crab	Quarterly	yes	AB	AB	AB	AB
PLZ - fish	Quarterly	yes	AB	-	AB	AB
PLZ – lobster	Quarterly	yes	AB	AB	AB	-
Brims Ness – winkles	Quarterly	yes	AB	-	AB	-

2. Surveillance of gaseous discharges (terrestrial monitoring).

The effects of gaseous discharges of radioactive waste on the local environment are determined by monitoring soil, grass, airborne particulate, freshwater and terrestrial food samples. The food samples are collected so that the dose to local residents can be assessed, whilst the other samples are collected to obtain information regarding levels of radioactivity surrounding the nuclear site and also as public reassurance measures. No milk samples are collected in the area this is because there are no dairy herds.

2.1 Continuous medium volume air samplers

SEPA have three medium volume air samplers in place around Dounreay, these are at Shebster, Reay and Balmore. The filters are changed every month and analysed for gamma emitting nuclides, total alpha and total beta activity. SEPA’s contractor has a programme of maintenance in place that ensures that the medium volume air samplers are in the best possible working order.

2.2 Grass and soil samples

Grass and soil samples are collected from three locations around the nuclear site, these are at Archvarasdal, Hallam Farm, and Borrowston Mains. Samples of soil and grass are collected twice a year. The analyses consist of gamma spectrometry and the determination of the activity concentration of the following nuclides: tritium, Sr-90, I-129, U-234, U-235, U-238, Am-241, Pu-238 and Pu-239/240.

2.3 Freshwater samples

Freshwater samples are taken from 4 nearby freshwater bodies, Loch Calder, Loch Shurrery, Loch Baligill and Heldale Water. Total alpha, total beta, tritium, Sr-90 and gamma analysis are undertaken.

2.4 Terrestrial food samples

The availability of locally produced foodstuffs dictates what can usefully be sampled in the area. SEPA have a nominal list of samples that they require collecting and analysing but this varies from year to year depending on local availability. This list is as follows, 4 samples of locally grown produce (potato, root crop, green vegetables, cereal), 1 sample of wild food (e.g. rose-hip, fungi, nettles), 1 sample of locally produced lamb, 1 sample of locally produced beef, 1 sample of locally produced offal.

The food samples are analysed for tritium, Sr-90, I-129, Am-241, plutonium nuclides and gamma emitting nuclides.

3. Effluent check monitoring.

SEPA undertake independent check monitoring of effluent, the results of which are compared with UKAEA’s own data. Six samples of effluent are collected from UKAEA Dounreay each year. The effluent samples checked include grab samples and quarterly bulk samples.

APPENDIX 4

Discharge limits for the UKAEA Dounreay site

1. Airborne discharges.

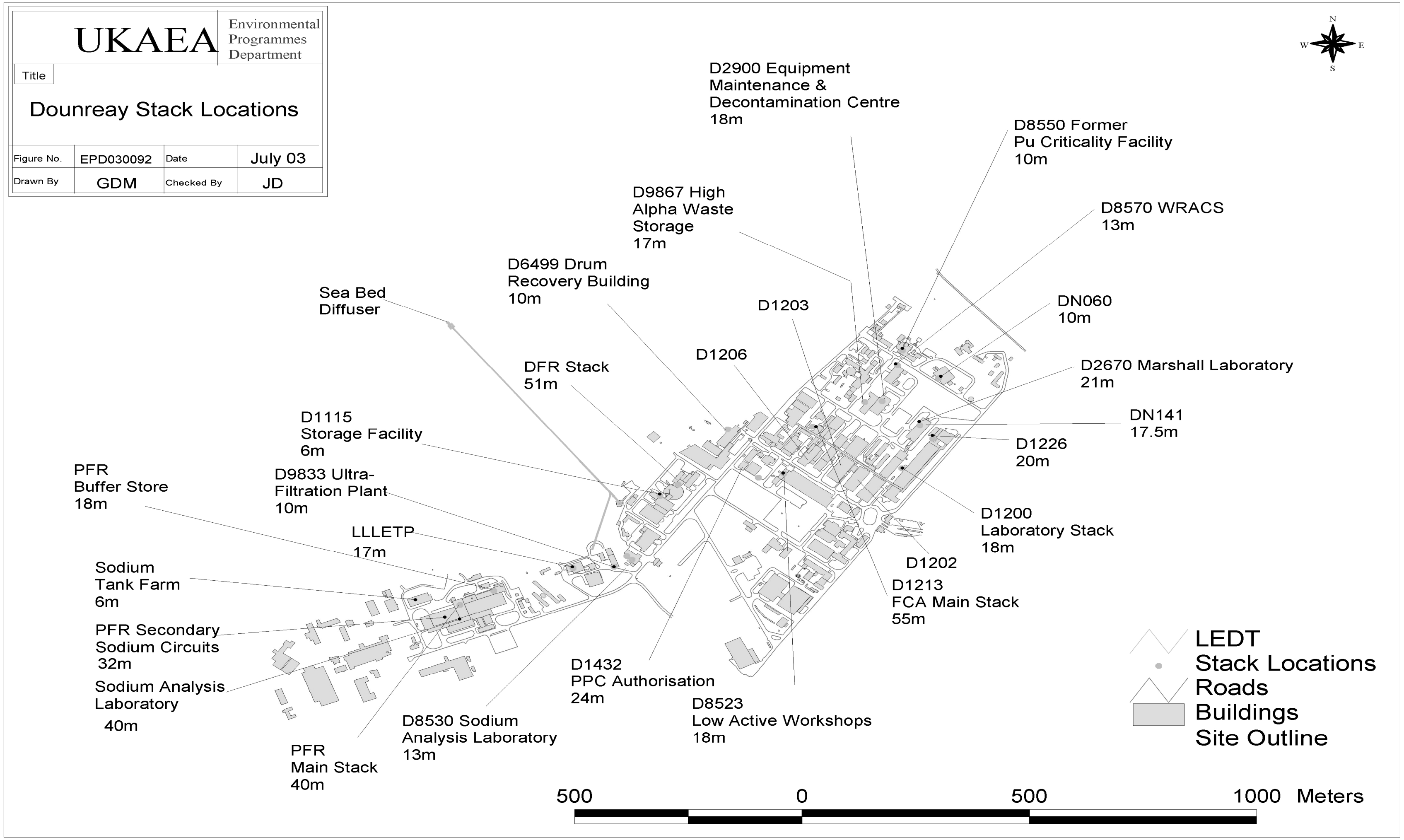
Facility	Radionuclide(s)	Annual limit
Prototype Fast Reactor	Alpha emitting radionuclides (excluding radon and daughters) associated with particulate matter. Beta emitting radionuclides (other than H-3 and Kr-85) associated with particulate matter. H-3 Kr-85	6 MBq 51 MBq 10.5 TBq 4 TBq
Prototype Fast Reactor Minor Sources	Alpha emitting radionuclides (excluding radon and daughters) associated with particulate matter. Beta emitting radionuclides (other than H-3) associated with particulate matter. H-3	60 kBq 500 kBq 200 GBq
Dounreay Fast Reactor	Alpha emitting radionuclides (excluding radon and daughters) associated with particulate matter. Beta emitting radionuclides (other than H-3 and Kr-85) associated with particulate matter. H-3 Kr-85	10 MBq 1.5 GBq 4.5 TBq 400 MBq
Fuel Cycle Area Main Stack	Alpha emitting radionuclides (excluding Cm-242 and Cm-244) associated with particulate matter. Beta emitting radionuclides (other than H-3 and Kr-85) associated with particulate matter. H-3 Kr-85 Sr-90 Ru-106 I-129 I-131 Cs-134 Cs-137 Ce-144 Pu-241 Cm-242 Cm-244	0.98 GBq 45 GBq 2 TBq 3 PBq 4.2 GBq 3.9 GBq 1.1 GBq 0.15 GBq 0.84 GBq 7 GBq 7 GBq 3.3 GBq 0.27 GBq 54 MBq
West Minor Sources	Alpha emitting radionuclides (excluding radon and daughters) associated with particulate matter. Beta emitting radionuclides (excluding H-3) associated with particulate matter. H-3	300 kBq 75 MBq 10 GBq
East Minor Sources	Alpha emitting radionuclides (excluding radon and daughters) associated with particulate matter. Beta emitting radionuclides (excluding H-3 and Kr-85) associated with particulate matter. Kr-85	13.7 MBq 371 MBq 1 TBq

2. Liquid discharges.

Facility	Radionuclide(s)	Annual limit
The Dounreay Site	Alpha emitting radionuclides taken together (other than Cm-242).	0.27 TBq
	Beta emitting radionuclides taken together (other than tritium).	49 TBq
	Tritium	30.8 TBq
	Co-60	0.46 TBq
	Sr-90	7.7 TBq
	Zr-95 + Nb-95	0.4 TBq
	Ru-106	4.1 TBq
	Ag-110m	0.13 TBq
	Cs-137	23 TBq
	Ce-144	0.42 TBq
	Pu-241	2.3 TBq
	Cm-242	0.04 TBq

APPENDIX 5

UKAEA Dounreay site – plan of facilities and stack locations



APPENDIX 6

UKAEA - Summary of the statutory environmental monitoring programme

1. Marine monitoring programme.

	Sample Type/ Monitoring	**Distance from Site/Frequency**	**Analysis/Monitoring**
INTERNAL DOSE	Winkles	2 sites <4km (Sandside, Crosskirk) monthly 1 site > 4km (Kirkebb) monthly	Gamma spec 6 weekly. Actinide analysis quarterly. Pu-241 and Sr-90 on annual bulks. Analysis confined to edible component.
	Crabs, Lobsters and Whelks	Caught 6 weekly in area between Holborn Head to Strathy Point.	
	Round and Flat Fish	6 weekly caught in area between Holborn Head to Strathy Point.	
	Salmon	Purchased from local salmon fishery. One sample at start and one at end of salmon fishing season.	Gamma spec and actinide analysis on each sample. Pu-241 and Sr-90 on annual bulk.
	Rootmat and Soil	Root mat soil at salmon net drying area. One sample at start and one at end of salmon fishing season.	Gamma spec and actinide analysis.
EXTERNAL DOSE	Beta Gamma Surveys of Intertidal Deposited Material	8 sites within 4 km weekly 10 sites > 4 km monthly	Gamma dose rate at 1m measured with an MC71 geiger muller tube and 6-80 integrating ratemeter. Beta contamination at contact with DP8 scintillation probe and electra integrating ratemeter.
	Salmon Nets	Weekly during salmon fishing season.	Contact beta dose rates measured using BP19 scintillation probe and electra integrating ratemeter.
	Salmon Net Store	End of salmon fishing season	Contamination measured using DP2 scintillation probe and PCM5 ratemeter.
	Strandline	Sandside – Beta Gamma alternate weeks. Dounreay Foreshore – Beta Gamma East / Beta Gamma West on alternate weeks	Beta survey using 1667 probe connected to data logger and GPS. Gamma survey using GM probe connected to data logger and GPS.
INDICATOR	Seaweed	13 locations in area 23 km east to 16 km west of site. Quarterly sampling.	Gamma spec of all samples.

2. Terrestrial monitoring programme.

	Sample type/ monitoring	Distance from Site/Frequency	Analysis
INTERNAL DOSE	Rainwater	Monthly sampling at High Volume Air Sampling (HVAS) stations	Gamma spec, actinide and Sr-90 analysis on each sample.
	Air Sampling (HVAS)	Continuous monitoring of air at six sites. Vulcan, Reay Golf Course, Shebster Water Works, Forss, Murkle and Wick Airport sampled monthly.	Gamma spec, actinide and Sr-90 analysis of each sample.
	Grass	In any week, 3 locations < 4km and 2 locations > 4km from site with the remaining locations the following week.	Gamma spec of individual samples monthly, Sr-90 on three monthly bulk and actinide analysis on six monthly bulk.
	Rootmat and Soil	In any quarter, 3 locations < 4km and 2 locations > 4km from site with the remaining locations the following quarter.	Gamma spec and Sr-90 on individual samples quarterly, and actinide analysis on six monthly bulk.
EXTERNAL DOSE	Gamma Survey	2 of 4 stations < 2 km and 2 of 4 stations > 2 km 6 weekly (Group 1) with the remaining locations the following 6 weeks (Group 2).	Gamma dose rate at1m and at contact using MC71 geiger muller detector and 6-80 integrating ratemeter
INDICATOR	Goats' Milk	Quarterly when available from local supplier	Gamma Spec, Sr-90, I-129/sample

APPENDIX 7

Radioactive particles in the marine environment

1. Summary of fragments recovered since 1999.

Year	Dounreay foreshore	Sandside Bay	Offshore
1999	11	5	15
2000	6	6	115
2001	3	3	122
2002	5	5	342
2003	3	24	56
2004 to 27th August	1	5	61

2. Frequency and extent of beach monitoring for fragments of irradiated fuel.

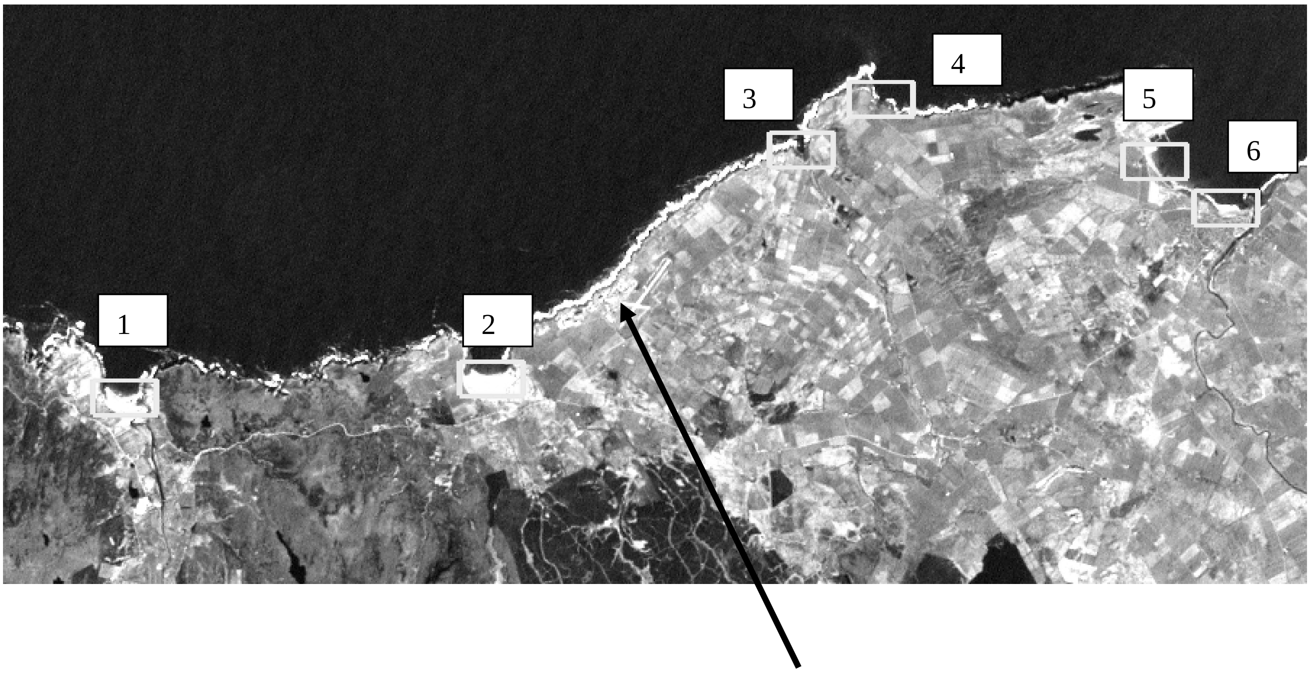
Beach	Extent of monitoring	Grid references (GRs)	Frequency of monitoring	Minimum Detection criteria
Sandside Bay	All of the sandy areas that can be accessed by a vehicle from MHWS to low water* between GRs in column 3.	295700, 966280 & 296690, 965780	Monthly	10^5 Bq of Cs-137 at 10 cm depth
Sandside Bay	Accessible sandy areas which do no permit vehicle access including north beach, harbour, sandy areas below Fresgoe House, bands of sand north east of the beach below the public lavatories and the sandy areas north of Isauld Burn.	295700, 966280 & 296690, 965780	Monthly	10^5 Bq of Cs-137 at 10 cm depth
Sandside Bay	Strandline that can be accessed by vehicle between GR's in column 3.	295700, 966280 & 296690, 965780	Fortnightly	10^5 Bq of Cs-137 at 10 cm depth
Thurso Bay	All sandy areas that can be accessed by a vehicle from MHWS to low water* between GRs in column 3.	311360, 968960 & 312070, 968850	Three times per year	10^5 Bq of Cs-137 at 10 cm depth
Scrabster Bay	All sandy areas that can be accessed by a vehicle from MHWS to low water* between GRs in column 3.	310040, 970180 & 310605, 969170	Three times per year	10^5 Bq of Cs-137 at 10 cm depth
Crosskirk Bay	All accessible sandy areas from MHWS to MLWS between GRs in column 3.	302860, 969900 & 302970, 970250	Twice per year	10^5 Bq of Cs-137 at 10 cm depth
Brims Ness	All accessible sandy areas from MHWS to MLWS between GRs in column 3.	304250, 971270 & 304410, 971030	Twice per year	10^5 Bq of Cs-137 at 10 cm depth

* Low water means as reasonably practicable to low water springs, but at least to neap low water.

APPENDIX 8

Beach monitoring

Groundhog Evolution



Routine beach monitoring locations:

1. Melvich (no fragments detected)
2. Sandside
3. Crosskirk (no fragments detected)
4. Brims Ness (no fragments detected)
5. Scrabster (no fragments detected)
6. Thurso (no fragments detected)

APPENDIX 9

Radioactive particles - support programmes

1. Beach monitoring technology.

A Beach Monitoring Steering Group has been established, comprising several experts in radiometric measurement. Its remit is to investigate systems, which may be proposed to UKAEA and that have the potential to improve the beach detection regime. Four meetings have been held up to August 2004. Suitable beach detection systems are to be evaluated and tested, with an assessment made by UKAEA on the next system to be deployed.

2. Best Practicable Environmental Option.

UKAEA recognise that in order to develop the best long term strategy for dealing with the particles legacy the full associated costs and risks must be balanced against the potential benefits. It is therefore UKAEA's intention to develop a Best Practicable Environmental Option (BPEO). This BPEO assessment will ensure that all feasible management options have been identified and compared on the basis of their health and environmental effects as well as their technical features and socioeconomic factors. The use of these attributes to assess the potential options is based on the recommendations of the Royal Commission on Environmental Pollution.

It is highlighted that, by its very nature, the BPEO process stimulates a large degree of stakeholder involvement throughout its duration. Consequently, the programme of BPEO delivery is subject to continual review. An internal Particle BPEO study group was set up in November 2002 to drive the BPEO process forward and several workshops have since been held. Stakeholder involvement in the BPEO was begun in early 2003 with public exhibitions in Reay and Thurso. Various candidate options were outlined at this exhibition and public comment invited. To ensure the BPEO process is open, transparent and impartial an External Steering Group has also been established.

3. Health and Risk studies.

Under contract to SEPA, NRPB is carrying out a formal assessment of the potential doses and the potential health effects that may be experienced by humans, if they were to come into contact, or ingest one of the Dounreay particles. In addition to any assessment of the potential hazard or harm, it is essential to the development of an overall risk-based argument to assess the frequency with which this harm may occur. UKAEA are therefore investigating further the potential for contact or ingestion of particles by humans, either through direct intervention or through the food chain. This work will involve both risk-specific field studies and detailed assessment of overall risk. It will seek to review and update the assessments previously prepared by NRPB and published by SEPA in 1998.

4. Numerical modelling of sediment movement within the Dounreay area.

In 1996 a limited programme of hydrographic surveys was initiated to characterise the seabed immediately off Dounreay. This was in response to the view that the pattern of arrivals of particles on the Dounreay foreshore indicated transport from the sea rather than a landbased migration route. This work was extended through 1997 – 99 to include wider areas of the seabed and a programme of gathering of local hydrodynamic data pertaining to currents, tides and wave patterns. A detailed swathe bathymetry survey of the near-Dounreay seabed area, covering the FEPA exclusion zone was carried out in 2001.

Since 1999, HR Wallingford have been engaged in the development of a numerical model of sediment movement within the Dounreay area. This has developed from a wide area 2D current model, through a local area 3D current model to the sediment tracking module. This module models the movement of discrete sand grains on the seabed and in the water column through a range of modelled weather events, and extends over a thirty year period. The primary objectives of this study were:

- To identify any specific locations where "particles" might be expected to accumulate, thus targeting future survey effort. Preliminary results from the model lead UKAEA to initiate the

"Remote Area" studies, successfully locating a limited number of particles to the East of Brims Ness.

- To assess the potential stability of the particles in the near Dounreay area. Or, formulated otherwise: have large numbers of particles left the local Dounreay area in the 35 years since their (likely) release into the marine environment due to sediment movement processes or, is the population of particles relatively stable?

Further development of the model continues. Recently the influence of wave asymmetry has been incorporated with significant effect on the distribution patterns. Further assessment of the influence of particle density, (the radioactive particles are more dense than the resident sediments) and of bioturbation on the mechanisms controlling particle burial and re-exposure on the surface sediments are currently being incorporated.

Consideration has been given to validation of the model. A programme of sediment tracking studies, involving the release of colour tagged sands was found to be extremely expensive and carried high project risk. Alternatively a critical review of the basic conceptual model supporting the numerical model has been initiated. The results of this will be reported by March 2005.

5. Loss of radionuclides from particles in-situ.

It has been observed that when particles are retrieved from the seabed off Dounreay, Sandside Beach or the Dounreay foreshore, there is a quantity of sediment from the immediate vicinity of the particle which contains elevated levels of Cs-137. In 2002, following the sectioning and analysis of 4 sediment cores containing particles, it is observed that one of the cores does show an activity profile which strongly suggests that Caesium is diffusing upwards and downwards from the particle (in fact this will be happening in 3 dimensions).

Other information from Particle Abrasion studies also points to fairly rapid initial loss of Cs-137 from particles into seawater during tank experiments. Rates of Cs-137 loss appear to be of the order of 10% of total activity in 1 month. If typical, this loss of Cs-137, even if the rate slows over time of contact with seawater/sediment, could be significant in reducing particle hazard, dispersing and diluting the Cs-137 in seawater or on sediment.

Lab tank experiments commenced in August 2004 to assess the degree and rate of loss of Cs-137 and other radionuclides from particles.

6. Particle Lifetime Studies and Characterisation.

It is necessary to establish the potential physical lifetime of the particles in the marine environment. In particular, it is fundamental to examine the physical and chemical interaction of the particles with the environment, identifying any processes by which particle breakdown or leaching of activity from the particles may occur. Some characterisation work already undertaken both at Dounreay and at Karlsruhe (Institute for Trans-Uranium Elements), by means of SEM/EDX analysis. Additional analysis of several DFR particles at Karlsruhe has been agreed with SEPA. This work is currently in progress.

It is intended to extend this work within the Chemistry Support Services (CSS) laboratories at Dounreay. This will involve detailed micro-level metallurgical analysis of a number of particles, together with specific examination of the corrosion products. This work will be resourced through the appointment of a university attached PhD student. Supervision and support will be provided from the University of Sheffield and from Professor Iain Baikie of KP Technology, Wick, in addition to UKAEA's Chemistry Support Services.

APPENDIX 10

The Dounreay Shaft

Figure 1

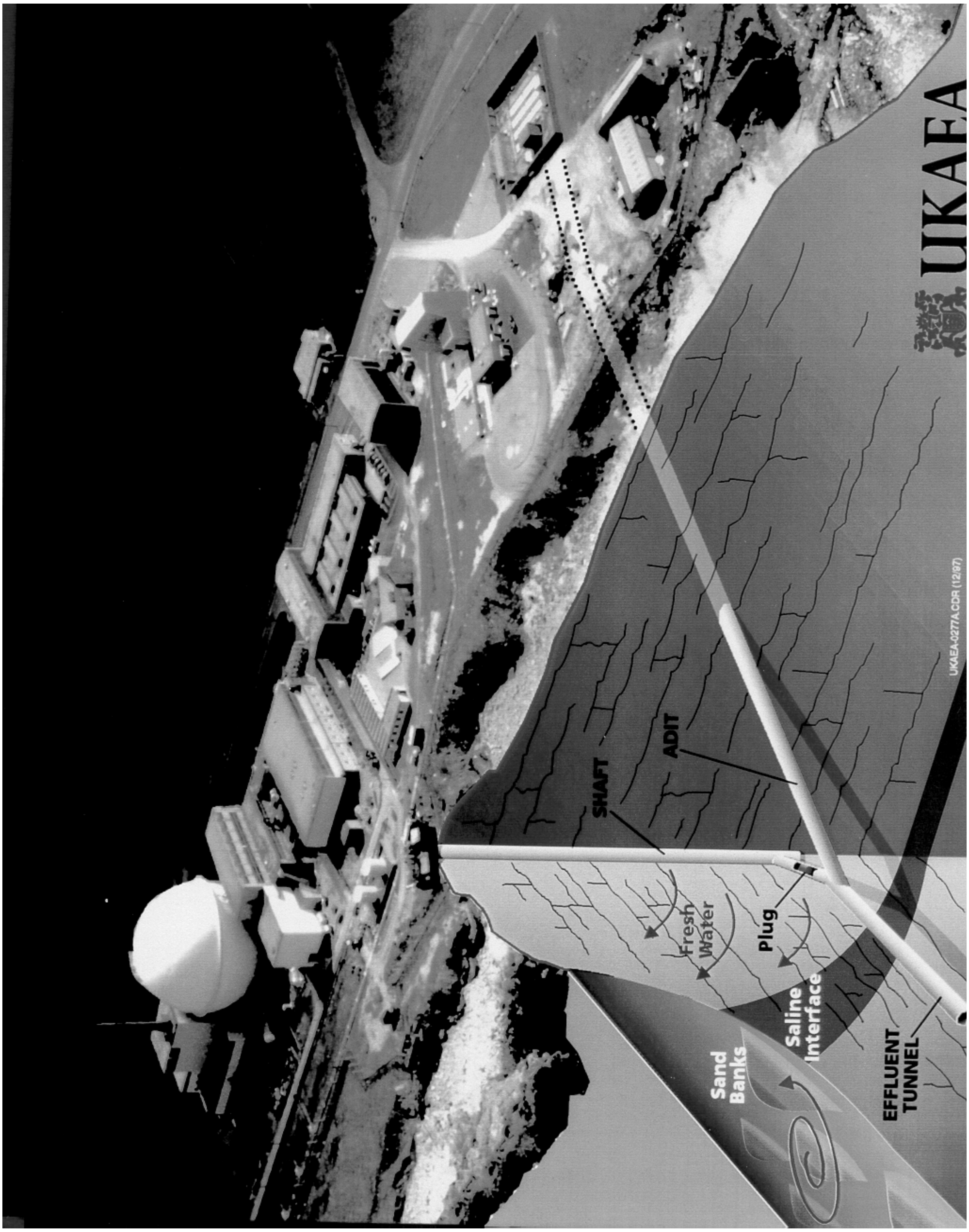


Figure 2

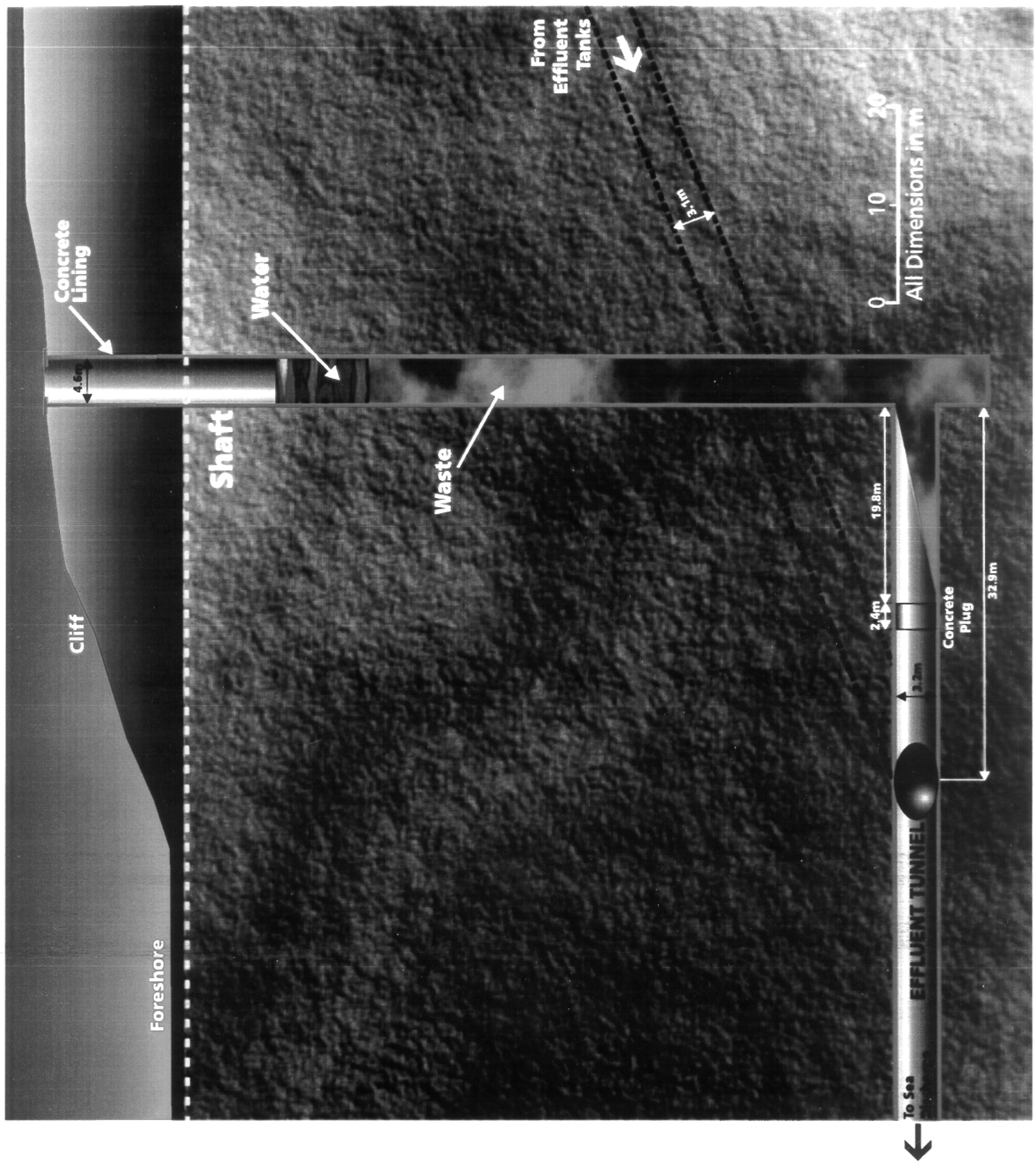
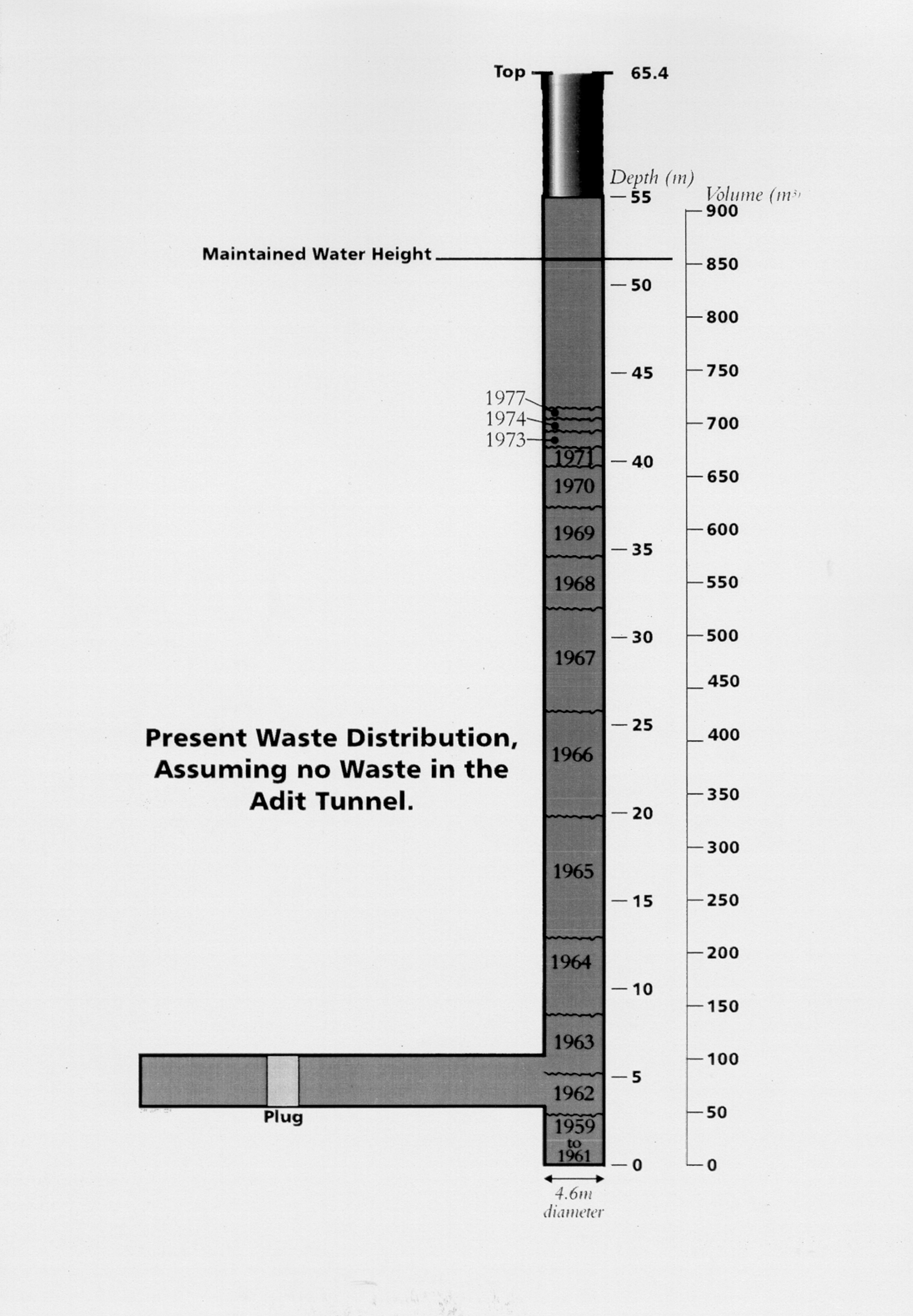

Concrete Lining
Water
Shaft
Waste
Cliff
Foreshore
From Effluent Tanks
3.1m
0
10
20
All Dimensions in m
4.6m
19.8m
2.4m
Concrete Plug
32.9m
3.2m
EFFLUENT TUNNEL
To Sea

Figure 3


Top
65.4
Depth (m)
Volume (m³)
Maintained Water Height
55
50
45
40
35
30
25
20
15
10
5
0
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
1977
1974
1973
1971
1970
1969
1968
1967
1966
1965
1964
1963
1962
1959 to 1961
Present Waste Distribution, Assuming no Waste in the Adit Tunnel.
Plug
4.6m diameter