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DIRECTORATE-GENERAL ENVIRONMENT
Directorate C – Environment and Health
ENV.C.4 – Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

DUNGENESS POWER STATIONS
KENT, UNITED KINGDOM

6 to 10 November 2000

Reference: UK-00/2

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 Kent during normal operations of the Dungeness A and B nuclear power stations.
SITE:	Kent, United Kingdom.
DATE:	6 to 10 November 2000.
REFERENCE:	UK-00/2.
INSPECTORS:	C. Sauer (Head of team) S. Van der Stricht L. Hornung-Lauxmann V. Tanner
DATE OF REPORT:	09.01.2002
SIGNATURES:	

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[signed]

L. Hornung-Lauxmann

TABLE OF CONTENTS

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TECHNICAL REPORT

1. ABBREVIATIONS

AEWTP	Active Effluent Water Treatment Plant
AGR	Advanced Gas Reactor
BE	British Energy Ltd
BD	Blowdown (purge of reactor circuit gas)
BNFL	British Nuclear Fuels Ltd
BPM	Best practicable means
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CRL	Central Radiochemistry Laboratory
CWO	Cooling Water Outfall
DAMAL	Dungeness A Medium Active Laboratory
DAP	Duly Authorised Person
DCC	Document Control Centre
DETR	Department of the Environment, Transport and the Regions
DSP	District Survey Programme (Dungeness A+B EMP)
DTI	Department of Trade and Industry
EA	Environment Agency
EC	European Commission
EMP	Environmental Monitoring Programme
EMS	Environmental Monitoring System
FMDT	Final Monitoring Delay Tanks
FPLES	Flow Proportional Liquid Effluent Sampler
FSA	Food Standards Agency
HEPA	High Efficiency Particulate Absolute (air filter)
HMIP	Her Majesty's Inspection of Pollution
HPI	Health Physics Instruction (Dungeness A)
HPWI	Health Physics Work Instruction (Dungeness B)
HSE	Health and Safety Executive
LGC	Laboratory of the Government Chemist
LSC	Liquid Scintillation Counter
MAFF	Ministry of Agriculture, Fisheries and Food
MCP	Management Control Procedure
MDA	Minimum Detectable Activity
MDP or MXD	Magnox Dissolution Plant
NAMAS	National Measurement Accreditation Service
NCAS	National Compliance Assessment Service (part of the EA)
NII	Nuclear Installations Inspectorate
OCR	(Reactor) Operation Control Room
QA	Quality Assurance
QNL	Quarterly Notification Level (of radioactive discharge)
RCG	Reactor Circuit Gas
RIFE	Radioactivity In Food and the Environment (report)
RIMNET	Radiation Incident Monitoring Network
RGD	Reactor Gas Dryer
RSU	Radioactive Safety Unit (of the FSA)
RUP	Reference Unit Power (nominal power output of a nuclear reactor)
SCA	Shield Cooling Air (Magnox reactor cooling ventilation system)
TID	Technical Implementation Document
TWST	Tritiated Water Storage Tanks
UKAS	United Kingdom Accreditation Service
VLA	Veterinary Laboratory Agency

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 Environment (DG ENV) and more in particular its Radiation Protection Unit (ENV C4) is responsible for undertaking these verifications.

For the purpose of such a review, a verification team from DG ENV visited the Dungeness A and B nuclear power stations located on the coast of Kent, operated by BNFL Magnox Generation Ltd and British Energy plc respectively.

The visit also included meetings with the Department of the Environment, Transport and the Regions (DETR), the Environment Agency (EA) and the Food Safety Agency (FSA). Details of the programme are given under section 3 below.

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

- Discharges of radioactivity into the environment.
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant exposure pathways.

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

- The operator's monitoring and control facilities for gaseous and aqueous discharges of radioactivity into the environment.
- The implementation of the statutory environmental radioactivity monitoring programme as performed by the operator.
- The operator's effluent and environmental laboratories, including aspects of quality assurance and control as well as document control.
- The independent environmental monitoring programme as performed by the competent authorities.

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

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1 Preamble

The Commission's decision to request the conduct of an Article 35 verification was notified to the UK Government on 21 August 2000 (letter referenced ENV/C1/CS/hm D (00) 520475, addressed to the UK Permanent Representation to the European Union). The UK Government subsequently designated the Department of Environment, Transport and the Regions (DETR) to lead the technical preparations for this visit.

3.2 Documents

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

[1] Directive 96/29/Euratom.

3.3 Programme of the visit

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

The programme provided for an information meeting with all parties involved (half a day) at Dungeness and, besides the on-site verification activities, for a visit to the Veterinary Laboratory Agency (VLA) located at Weybridge. The VLA is contractor to the Food Standards Agency (FSA) and performs radiochemical analyses on environmental samples.

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

- Magnox and Advanced Gas Reactor (AGR) power stations.
- Discharge arrangements at Dungeness A and B power stations.
- The operator's radiological environmental monitoring programme.
- The Environment Agency (EA) monitoring programme.
- The FSA monitoring programme.

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

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

The verifications were carried out in accordance with the programme.

3.4 Representatives of the competent authorities and the operators

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

The Department of the Environment, Transport and the Regions:

Dr M. Hum	Head of International Policy – Radioactive Substances Division

The Environmental Agency:

Dr R. Allot	Team Manager, Radiological Monitoring and Assessment Team National Compliance Assessment Service
Dr J. McHugh	Strategic Policy Manager – Radioactive Substances Regulation
C. Lloyd	Process Industry Regulation Officer - Radioactive Substances Regulation

Food Standards Agency:

Ms C. Morris	Head of Radiological Surveillance and Chernobyl Branch Radiological Safety Unit, Contaminants Division

Veterinary Laboratory Agency:

T. Dell	Head of Radiochemistry
R. Lukey	Quality Manager (sample management & gamma spectrometry)

BNFL Magnox Generation – Dungeness A:

Dr L. S. Austin	Environment, Health, Safety and Quality Unit BNFL Magnox Generation HQ (Berkeley, Gloucestershire)
W. C. Root	Station Manager
Dr K. J. Odell	Central Radiochemical Laboratory (Berkeley, Gloucestershire)
B. J. Gosling	Head of Health Physics and Chemistry
P. W. Crow	Head of Safety and Environment
D. Ford	Health Physics Assistant

D. Dicker	Health Physics Assistant
T. Horwood	Health Physics Assistant

British Energy – Dungeness B:

Dr M. J. Hurst	Senior Environmental Officer – Health Safety & Environment Division British Energy HQ (Barnwood, Gloucestershire)
Dr A. Spurr	Station Director
M. B. Jackson	Technical & Safety Support Manager
D. J. Cooper	Head of Environmental Safety Group – Station Health Physicist
J. M. Cheese	Health Physicist
J. I. Parker	Health Physicist (liquid and gaseous discharge arrangements)
P. G. Northfield	Environmental Safety Assistant (site laboratory)
R. Hellen	Environmental Safety Assistant (environmental survey laboratory)
D. M. Sage	Environmental Safety Assistant (environmental survey laboratory)

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

4. THE DUNGENESS POWER STATIONS - DESCRIPTION

4.1 The power stations

There are two nuclear power stations at Dungeness: Dungeness ‘A’ which is a twin Magnox reactor station having a reference unit power (RUP) of 440 MW and Dungeness ‘B’ which is a twin Advanced Gas Cooled (AGR) station with a RUP of 1110 MW.

The Dungeness site is situated on the south Kent coast immediately west of Dungeness Point, 100 km south-east of London. The nearest point in another European Union Member State is Cap Griz Nez, France, 40 km to the east; Belgium and The Netherlands are respectively 110 and 165 km distant.

Dungeness ‘A’ is operated by BNFL Magnox Generation and Dungeness ‘B’ is operated by British Energy Generation Ltd.

A site plan and technical details of both stations are listed in Appendix 3.

4.2 The local environment

Dungeness is one of the few areas in the UK where the natural plant communities have been virtually unmodified by traditional agricultural activities. The area is recognised as providing an exceptional record of evolution in coastal geomorphology and is the largest example of a cuspate shingle foreland in Britain. The beach reflects some 5000 years of coastal development and important features are the exposed shingle ridges and the diverse range of flora and fauna that have developed on such an unstable, hostile substrate.

The area around the Dungeness power stations has been notified as a Site of Special Scientific Interest (SSSI) under section 28 of the Wildlife and Countryside Act 1981 and further areas adjoining the SSSI are designated as parts of a National Nature Reserve (NNR). In comparison to the area the SSSI and NNR serve, the land occupied by the two Dungeness power stations is small (see Appendix 4).

5. COMPETENT AUTHORITIES & LEGAL BACKGROUND

5.1 Introduction

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), 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).

Within England, Wales and Scotland, RSA 93 provides the framework for controlling the generation and disposal of solid, aqueous and gaseous radioactive waste so as to protect the public and the environment. In particular, RSA 93 requires prior authorisation for the disposal or discharge of radioactive waste to the environment. Since 1996 the responsibility for granting an authorisation in England and Wales rests with the Environment Agency (EA).

Prior to the formation of the EA in 1996, Her Majesty's Inspectorate of Pollution (HMIP) and the Ministry of Agriculture, Fisheries and Food (MAFF) jointly granted the radioactive waste discharge authorisations. Upon the formation of the EA, MAFF became a statutory consultee in the process of determining radioactive waste discharge authorisations. At the same time MAFF also transferred its responsibilities for radiological monitoring of the non-food pathways to the EA. Eventually MAFF transferred its role as statutory consultee to the Food Standards Agency (FSA) in April 2000.

Under the provisions of RSA 93, the operator of a site licensed under the Nuclear Installations Act 1965 will have to apply to the EA for an authorisation to dispose of radioactive waste, or for a variation to such an authorisation. Before determining such an application for an authorisation or a variation, the EA must consult the FSA.

The EA formally requires operators with significant radioactive waste discharges to undertake monitoring of the environment around their sites. These arrangements are normally specified within Implementation Documents that accompany the radioactive waste discharge authorisations.

The EA also commissions independent monitoring of radioactive waste discharges and radiological monitoring of the environment. Independent monitoring is implemented so as to provide checks on the adequacy and the results of the operator monitoring programmes.

The FSA have also a responsibility for independent radiological monitoring and more in particular with respect to the food chain, both within the terrestrial and marine environments.

-	Effluent monitoring	EA
-	Environmental monitoring for non-food pathways	EA
-	Food chain monitoring	FSA

A Working Agreement between the EA and the FSA specifies the above responsibilities. The purpose of the agreement is to provide working arrangements between the EA and the FSA, to discharge their respective responsibilities and exercise their functions under or in consequence of RSA 93 for premises in England and Wales. The objectives of this Agreement are to ensure that in respect of regulation of disposals of radioactive waste:

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

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

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

5.2 Radioactive discharge authorisations

5.2.1 Certificates of authorisation

The disposal of radioactive waste from nuclear establishments in England and Wales is permitted, subject to limitations and conditions set out in Certificates of Authorisation granted by the EA under RSA 93 (as amended by EA 95). The Certificates of Authorisation determine the conditions and limits for the amount of radioactive substances discharged in solid, aqueous or gaseous form from each licensed site. The limits are expressed both as gross alpha and beta values and as nuclide-specific values that may be discharged over specific periods of time. Standard conditions with respect to record keeping, the use of best practicable means to reduce the activity in all the waste discharged, and the means of discharge are included in all authorisations. Also included are provisions for monitoring programmes, including environmental monitoring and analysis. Failure to comply with these authorisations is an offence under Section 32 of the Act.

5.2.2 Independent verification

The EA requires operators of nuclear licensed sites to provide samples of their liquid effluents for independent radiochemical analysis. The results provide checks on site operators' returns and insights into their quality assurance (QA) procedures and analytical techniques. The sampling consists of either single spot samples or monthly or quarterly bulked samples as appropriate. Currently the analyses are undertaken by the Laboratory of the Government Chemist (LGC) at its laboratories in Teddington (Middlesex) using analytical methods most of which are accredited by UKAS.

5.2.3 Discharge limits applicable to the Dungeness site

Current Authorisations for the disposal of aqueous and gaseous waste were granted to Dungeness A and B in July 1994. The current authorisation limits are detailed in Appendix 5.

6. DUNGENESS A – RADIOACTIVE DISCHARGES

6.1 Introduction

An Authorisation to dispose of radioactive waste gases, mists and dusts and an Authorisation to discharge radioactive liquid effluents from the Dungeness A+B Power Station are granted by the Environment Agency (EA) under the terms of the Radioactive Substances Act 1993.

Details of the approved outlets for gaseous and liquid discharges and of the samples taken of discharges from these outlets are given in the respective Implementation Documents. Appendices 6.1 (gaseous) and 7.1 (liquid) show schematics and details for these approved routes.

6.2 Atmospheric discharges

It is a requirement of the Authorisation that 'best practicable means' (BPM) is used to minimise discharges of radioactive materials to atmosphere. In general terms this is achieved by a combination of minimising the amounts of activity which could become airborne within the plant and by filtering the gases to be discharged through appropriate filters.

All HEPA (High Efficiency Particulate Absolute) filter systems and charcoal filters designed to remove iodine must undergo an efficiency test at intervals not exceeding two years or when any material change in their integrity has occurred (e.g. after maintenance).

6.2.1 General

There are seven systems [(2)] where the discharges of gaseous radioactivity can occur:

- Shield Cooling Air
- Blowdown Plant
- Main Contamination Ventilation Plant
- Minor Contamination Ventilation Plant
- Dungeness A Medium Active Laboratory Extract Systems
- Magnox Dissolution Plant
- Low Level Active Waste Facility Incineration Stacks

With exception of the incinerator stacks, each system discharges via an appropriate filter plant and samples of the discharge are collected downstream of the filter. In addition to the sampling of these discharge points, routine analysis of reactor circuit gas (RCG) is undertaken, to provide an early indication of any significant change in the total radioactivity of RCG and also to measure particular isotopes as identified in the Authorisation (H-3, S-35 and C-14).

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[2] Section 6.2 of this report focuses on the two main discharge routes (shield cooling air and blowdown). Together both routes represent the majority of radioactive releases to the atmosphere.

The early Magnox stations (including Dungeness A) were constructed with steel pressure vessels that require an additional biological shield (built in concrete). In order to maintain integrity when the reactors are at power, the concrete requires cooling. Therefore the space between vessel and shield is swept by a constant airflow (shield cooling air – SCA). This SCA is subject to neutron irradiation while passing between the pressure vessel and the inner face of the biological shield, such that Ar-41 is produced by neutron activation of natural Ar-40 in the air supply [(3)].

Discharges of RCG (purge or 'blowdown' – BD) are discrete discharges of higher activity. BD is controlled and requires an accredited health physicist to confirm that the discharge is acceptable (not transgressing discharge authorisation limits).

The leakage rate of RCG is determined (by assessment of the loss of CO_2 from the reactor) and monitored on a daily basis. The data obtained are used to compile the monthly reports of radioactive gaseous discharges to the EA.

6.2.2 Sampling regimes

Plant	Sample type & frequency	Analysis undertaken
SCA and BD.	GFA-ACG/B, 24 hour continuous sample.	Alpha and beta counting.
RCG.	GFA-ACG/B, 10 minute daily spot sample. Bubblers (H_2O/KOH), 20 minute daily spot sample.	Alpha and beta counting. S-35 H-3 C-14
Control Face and Fuel Face Active Vent Discharge.	GFA, 24 Hour continuous sample.	Alpha and beta counting.
Minor Contamination Ventilation.	GFA, spot 24-hour sample, check every month.	Alpha and beta counting.
DAMAL Extract Systems	GFA, 24 hour continuous, changed and assessed weekly. Maypack, changed and assessed weekly.	Alpha and beta counting, gamma spectrometry.
Magnox Dissolution Plant.	GFA, 24 hour continuous, changed and assessed weekly.	Alpha and beta counting. H-3 C-14

Notes: 1. Alpha and beta counting is undertaken initially and then again after 72 hours, the latter result being used for the monthly report to the EA.
2. GFA – Glass Fibre Particulate Filter paper (sampling efficiency of 98% for particles of 1.6μm).
3. ACG – Carbon Impregnated Filter paper.

The detailed schedule of sampling (per outlet) and radionuclide analysis is given in Appendix 6.2.

6.2.3 Shield cooling air samples

- Argon-41

The discharge rate of Ar-41 is dependent on three factors:

- Neutron flux (as a direct function of thermal power).
- SCA flow rate.
- Residence time of SCA in the neutron flux.

The latter two factors vary inversely with each other, so their product is constant for a given reactor. Therefore the discharge of Ar-41 can be expressed as a linear function of thermal power. The relationship between Ar-41 discharge and thermal power had been quantified in the past (and confirmed in more recent times) by measuring Ar-41 in SCA.

[3] Although Ar-41 is also discharged via the reactor coolant (due to trace impurities of Ar-40 in the supplied CO_2), the quantity of Ar-41 discharged is about 1% of the discharge via the SCA. Discharges of Ar-41 via reactor coolant are therefore not routinely determined.

The discharge of Ar-41, over any given period, is calculated from this known relationship and the thermal power produced during the same period.

- Particulates

Each reactor is fitted with three shield cooling air extraction fans. Each fan has its associated vent stack. The normal state of the shield cooling fans is that two are in use and the remaining is on standby. Each vent stack has a pair of inlet and return sampling points to which a particulate sampling trolley (mobile sampling system) can be connected. Sampling probes are designed to ensure isokinetic sampling. In addition a pair of gaseous activity sampling points are also provided. The extraction fans are fitted with fault alarms connected to the reactor operation control room (OCR).

One particulate sampling trolley is connected to each vent stack in service. A pump in the trolley continuously generates a nominal sampling flow of 40 ± 4 litres per minute through the particulate filter. The sampling filters (carbon impregnated filter paper and glass fibre particulate filter paper) are replaced daily. The collected filter papers are send to the effluent laboratory for assay of impacted activity (gross beta and alpha counting). The trolleys are not alarmed in case of failure.

6.2.4 Reactor gas sampling

- Tritium, Sulphur-35 and Carbon-14

Reactor gas is sampled from the reactor gas coolant circuit. The sampling equipment consists of permanently installed pressure-reducing panels and mobile sampling trolleys (two trolleys per reactor, ensuring redundancy). Each trolleys contains a sample pump, a combustion air pump, a flow meter, a furnace to oxidise the gas stream and a set of sampling bottles (‘bubblers’). A set of bubblers is made up of three interconnected 150 ml bottles, filled with distilled water (the first two) and 0.5 M KOH (the last bottle in the sequence). A RCG sample is taken after having purged the sample line, by sending gas through the bubblers during 20 minutes and recording the total sample flow. Such a gaseous isotope sample is taken once a day (spot sample) and the quantities of H-3, S-35 and C-14 assessed by liquid scintillation counting (LSC).

- Particulates

The particulate radioactivity of reactor gas is also measured once a day (spot sample). The sampling equipment consists of permanent pressure-reducing panels and filter assemblies (two filter assemblies per reactor, ensuring redundancy). A RCG sample is taken after having purged the sample line, by sending gas through the filter assemblies (similar filters as described under section 6.2.3) during 10 minutes and recording the total sample flow. Samples are submitted to gross beta counting (with reference to a Cl-36 standard) and alpha counting (with reference to a Pu-239 or an Am-241 standard).

6.2.5 Blowdown sampling

The vent stacks are not fitted with extraction fans; a BD discharge is performed by difference of pressure between the RCG circuit and the atmosphere.

The 4 blowdown vent stacks are equipped with particulate sampling units whose fault alarms are connected to the OCR. The sampling units consist of filter panels (GFA and ACG filter papers) and associated flow meters. Flow control instruments ensure that, as near as practicable, isokinetic sampling is obtained for all BD flow rates. BD flow control is designed to sample at a ratio of 1:2075 with a lower cut-off BD rate of 10 kg/minute.

Filter papers are collected / exchanged after every BD operation and submitted to gross beta and alpha counting.

6.2.6 Emergency situations

Each reactor is provided with an Iodine Absoption Plant that would be used to remove I-131 in case of an emergency situation. An emergency situation occurs when:

- A blowdown is performed with a severely damaged fuel element present in the core.

- A depressurisation accident occurs and is followed by a channel fire [4].

Each Iodine Absorption Plant is fitted with an iodine break through monitoring system.

In emergency situations additional sampling is carried out to assess I-131 discharges by fitting charcoal filters into the particulate sampling devices connected to the:

- The SCA vent stacks (trolleys).
- The BD stacks.

These charcoal filters ('Maypacks') consist of 45 cm³ of charcoal sandwiched between two 5 cm diameter GFA filter papers. Maypacks are submitted to gamma spectrometry when returned to the laboratory.

6.2.7 Assessment of particulate samples

Counting instrument background and efficiency checks must be completed satisfactory before assessing the sample. Samples (GFA filter papers) are normally counted immediately after the sample has been obtained.

Samples are nominally counted for 100 seconds for beta activity and for 1000 seconds for alpha activity. The recorded total sample flow and the count rates obtained from the measurement are used to calculate the gross beta and or alpha activity, expressed in Bq/m^3.

Any samples with activities greater than 1 Bq/m^3 (beta) or 0.01 Bq/m^3 (alpha) are re-assessed after a one-hour delay or after a three-hour delay respectively (first decay count).

Any re-assessed beta sample still having an activity between 1 and 5 Bq/m^3 must be assessed again (1000 seconds) as near to 72 hours after sample taking as possible. Any re-assessed alpha sample still having an activity greater than 0.01 Bq/m^3 must be assessed again as near to 72 hours after sample taking as possible.

Any sample with initial activities greater than 10 Bq/m^3 (beta) or 0.03 Bq/m^3 (alpha), and confirmed after the 72 hour recount, are earmarked for gamma spectrometry.

6.2.8 Recording of results

Recording of results, measurement error handling, minimum detectable activities, etc. are presented in Appendix 8.1.

6.2.9 Reporting of results

All results obtained are reported monthly to the EA. Reporting templates are presented in Appendix 9.1.

6.3 Liquid discharges

6.3.1 General

Liquid effluents are generated at the following areas:

- a. Soluble activity from the irradiated fuel cooling ponds.
- b. Soluble activity from sludge and resin tanks.
- c. Washings from plant and fuel flask decontamination,
  drainage from change rooms and other reactor areas.
- d. Active laundry.
- e. Water from reactor coolant dryers (tritiated water).
- f. Magnox dissolution plant.

All aqueous active waste arising from categories a to d is directed to the Active Effluent Water Treatment Plant (AEWTP) for treatment by filtration, pond water is treated by filtration and ion exchange. After treatment the arisings are send to two intermediate holding tanks, called Final Delay Tanks (FDT), each of a capacity of 100 m³, the contents of which are sampled and analysed before authorisation is given to discharge.

4 Safety rules require an immediate shutdown of the reactor in case of fire.

Tritiated water from the dryers is removed from the dryer plant in carboys and poured into FDT-2 in limited amounts as authorised by the Health Physicist.

The Magnox Dissolution Plant (MXD) decontaminates parts of magnox fuel cans. The liquor from the MXD is filtered and possibly treated by a chelating resin before being sent to two intermediate holding tanks, called Collection Monitoring Tanks (CMT), each of a capacity of 45 m³, the contents of which are sampled and analysed before authorisation is given to discharge.

There are two authorised routes for the discharge of liquid effluents, one via the AEWTP, the other from the MXD. Discharge levels should never exceed the Authorisation's Annual Limit and rarely exceed the Quarterly Notification Level (QNL).

Written procedures are in place ensuring that no unauthorised discharge occurs. The written procedures are compounded by exchange interlock key systems together with associated administrative tools requesting signatures by Duly Authorised Persons (DAP), at al relevant decisional levels.

The FDT and CMT systems are interlocked to ensure discharges of either system cannot occur together. Each system has its own discharge line; both lines connect into a discharge pipe. The pipe then discharges into the station's cooling water system return leg. Mixing the discharge with the coolant water flow ensures a high degree of dilution of activity before final release into the marine environment.

Between 12 to 15 FDT tanks and approximately 2 CMT tanks are discharged to sea per month.

6.3.2 Sampling of FDT and CMT tanks

- Pre-discharge samples

After a timer/interlock controlled 5-hour recirculation of the FDT/CMT and after purging of the sample lines, two 250 ml samples are taken from the tank for quick assessment of activity concentration. Sample bottles must be labelled according to written procedure.

The sample is then assessed for 'soft' (tritium only) and 'hard' activity on a liquid scintillation counter (LSC). If the results are exceeding 20 GBq for soft activity and 3 GBq for hard activity (signing limits) a DAP signature is required. The DAP checks and ensures that the discharge will not breach the Authorisation's QNL and Annual Limit before granting permission to discharge.

Pre-discharge samples are retained for 12 months before disposal.

- Discharge proportional samples

The discharge pipe is equipped with a flow proportional liquid effluent sampler (FPLES). The FPLES takes approximately 30 cm³ of sample per m³ discharged. Sample bottles must be labelled according to written procedure.

6.3.3 Assessment of FPLES samples

- Tritium

An appropriate quantity of sodium sulphite and sodium hydroxide is added to 100 cm³ of FPLES sample. The mixture is then distilled. The first 15 cm³ of distillate is rejected as waste, the second 15 cm³ is retrained and counted by LSC.

- Other radionuclides

Three drops of hydrogen peroxide and 1 ml of 6M nitric acid are added to 5 ml of FPLES sample in a LSC vial. The mixture is then evaporated to dryness using an infra-red lamp. Finally 1 cm³ of 0.1M nitric acid is added to resolve the dry residue and the sample counted by LSC.

- Caesium-137

About 250 ml of FPLES sample is counted for Cs-137 by gamma spectrometry.

6.3.4 Quarterly bulk samples

Quarterly bulk samples from the FDT and CMT are sent to the Central Radiochemical Laboratory (CRL) at Berkeley for detailed isotopic analysis. The CRL provides bulk sample bottles containing 2 litres of 6M nitric acid. To these a pro-rata of 1 cm^3 per discharged m^3 is added from the individual FDT or CMT pre-discharge samples taken during the quarter under scrutiny. Before returning the bulk sample (labelled according to written procedure) to the CRL, 250 ml are poured off and retained for quality assurance checks on the results of the routine analytical programme.

6.3.5 Quality assurance

Both the station laboratory and the CRL use identical analytical methods to assess the quarterly pre-discharge bulk samples with respect to contents of Cs-137, other radionuclide and tritium. The station laboratory performs the assessments as described under section 6.3.3 above in triplicate. Both laboratories then compare their results.

6.3.6 Calibration standards and frequencies

- The Wallac 1409 liquid scintillation counter

Calibration using quenched standards is performed on an annual basis. For calibration after servicing or repair no fresh standards need to be prepared providing that the current standards are not older than 6 months. Calibration records are kept for QA purposes.

- The EC&G Ortec gamma spectrometer

A two-point energy calibration is performed on a daily basis by counting the most recent mixed nuclide standard of the 250 ml geometry. The counting time must be sufficient to give approximately 1.0 E+04 counts in the Co-60 1332 keV peak.

Efficiency calibrations are performed when necessary (e.g. pole zero adjustments).

6.3.7 Recording of results

Recording of results, measurement error handling, minimum detectable activities, etc. are presented in Appendix 8.1.

6.3.8 Reporting of results

All results obtained are reported monthly to the EA. Reporting templates are presented in Appendix 9.1.

7. DUNGENESS B – RADIOACTIVE DISCHARGES

7.1 Introduction

Authorisations to dispose of radioactive waste gases, mists and dusts and to discharge radioactive liquid effluents from the Dungeness B Power Station are granted by the Environment Agency (EA) under the terms of the Radioactive Substances Act 1993.

Details of the approved outlets for gaseous and liquid discharges and of the samples taken of discharges from these outlets are given in the respective Implementation Documents. Appendix 6.2 (gaseous) and 7.2 (liquid) show schematics and details for these approved routes.

7.2 Atmospheric discharges

It is a requirement of the Authorisation that 'best practicable means' (BPM) is used to minimise discharges of radioactive materials to atmosphere. In general terms this is achieved by a combination of minimising the amounts of activity which could become airborne within the plant and by filtering the gases to be discharged through appropriate filters (Appendix 6 provides details). In the case of discharges of reactor gas, which take the form of discrete discharges of higher activity, a system of control has been established which requires an Accredited Health Physicist to confirm that the discharge is acceptable and to specify any extra controls that need be applied.

7.2.1 Argon-41

All argon-41 discharges are assumed to be via either the common CO_2 blowdown route serving both reactors and ancillary sources (e.g. fuelling machine & buffer stores) or from reactor pressure circuit leakage, all considered to be discharged via the HV1A system. Estimates of discharges are made from measurements of reactor Ar-41 inventory and CO_2 blowdown and leakage rates, as follows:

- Reactor 21 & 22 Ar-41 inventories are continuously measured by gamma spectrometers. A computer logs hourly mean values. A daily average inventory figure is calculated.

- Monthly Ar-41 discharges resulting from reactor leakage are estimated by combining the CO_2 leak-rate from each reactor with the Ar-41 inventories. This leakage is assigned to the HV1A discharge system. Ar-41 discharge figures through reactor leakage are calculated, monthly total and daily maximum and minimum values are reported monthly to the EA.

- Details of CO_2 discharges via the blowdown route greater than 4.5 kg are logged by computer. Ar-41 discharges for the month are then estimated by combining the mass of CO_2 blown down from each reactor and ancillaries with the Ar-41 inventories. Ar-41 discharge figures through blowdown are calculated, monthly total and daily maximum and minimum values are reported monthly to the EA.

The total figures above are summed to give the overall monthly total for Ar-41 discharged. This latter figure, together with the current calendar quarter and rolling 12 months totals, are also reported to the EA every month.

7.2.2 Sulphur-35

The blowdown system is sampled continuously when the blowdown route is in service. All ventilation systems are sampled continuously with the exception of HV13, which is only sampled when the system is in service. Discharges are measured as follows:

- Samples are taken by passing a representative fraction of the discharge gas stream through an oxidation furnace followed by a bubbler containing dilute hydrogen peroxide solution. Each bubbler is normally replaced three times a week and taken to the active laboratory for analysis.

- For the analysis, an aliquot of bubbler liquor is added to a counting vial of liquid scintillant and counted in a scintillation counter reporting H-3 and S-35 activities. The counter programme is calibrated using H-3 and C-14 standards with quench correction.

- For each system the bubbler results are recorded on a monthly summary sheet. Sample activities are multiplied by the appropriate sample fraction ratio to calculate the activity discharged via each system. The total and maximum & minimum discharge in any sampling period, for each system, are reported monthly to the EA.

The total figures above are summed to give the overall monthly total for S-35 discharged. This latter figure, along with the calendar quarter and rolling 12 months totals, are also reported to the EA every month.

7.2.3 Carbon-14

All C-14 discharges are assumed to be via either the common CO_2 blowdown route serving both reactors and ancillary sources or from reactor pressure circuit leakage, all considered to be discharged via the HV1A system. Estimates of discharges are made from measurements of reactor C-14 inventory and CO_2 blowdown and leakage rates, as follows:

- Reactor 21 & 22 C-14 inventories are determined twice weekly using bubbler systems. The method used is that of absorption of CO_2 to saturation in a NaOH bubbler. Analysis is performed by liquid scintillation counting calibrated against a C-14 standard with quench correction. The obtained C-14 inventory results are used to estimate daily discharges.

- Monthly C-14 discharges via the HV1A system, are estimated by combining reactor leakage rates with C-14 inventories (as described for Ar-14 above). C-14 discharge figures through reactor leakage are calculated, monthly total and daily maximum and minimum values are reported monthly to the EA.

- Carbon-14 discharges for the month via the blowdown route are estimated by combining the mass of CO_2 blown down from each reactor and ancillaries with C-14 inventories (as described for Ar-41 above). C-14 discharge figures through blowdown are calculated, monthly total and daily maximum and minimum values are reported monthly to the EA.

The total figures above are summed to give the overall monthly total for C-14 discharged. The latter figure, together with the maximum weekly, current calendar quarter and rolling 12 months totals, are also reported to the EA every month.

7.2.4 Tritium

The same bubblers used to determine S-35 discharges sample for gaseous tritium. The blowdown system is sampled continuously when the blowdown route is in service. All ventilation systems are sampled continuously with the exception of HV13, which is only sampled when the system is in service. Samples are normally changed and analysed 3 times per week. Analysis is carried out jointly with the analysis for S-35.

For each system the daily bubbler results are recorded on a monthly summary sheet. Sample activities are multiplied by the appropriate sample fraction ratio to calculate the activity discharged via each system. The total and maximum & minimum discharge in any sampling period, for each system, are reported monthly to the EA.

The total figures above are summed to give the overall monthly total for H-3 discharged. This latter figure, along with the calendar quarter and rolling 12 months totals, are also reported to the EA every month.

7.2.5 Iodine-131

Discharges of I-131 are sampled by passing a representative fraction of each relevant discharge gas stream through an activated charcoal pack, which is then measured for beta/gamma activity. In those systems sampled for iodine activity the charcoal packs form an integrated sampling system with the particulate filter papers, except for HV1A which has a separate iodine-sampling loop. The blowdown system is sampled continuously when the blowdown route is in service. All ventilation systems are sampled continuously with the exception of HV13, which is only sampled when the system is in service. Samples are normally changed and analysed weekly.

The sampling system automatically records countrates. If the countrates are above pre-determined action levels, the packs are removed and a more detailed analysis is carried out by gamma spectrometry. Any significant discharge of I-131 will thus be identified within 48 hours (100 hours for public holiday periods).

The daily countrates are recorded and multiplied by the appropriate sample fraction ratio to calculate the estimated activity discharged via each system. At the end of each month the total and maximum & minimum discharge in any sampling period, for each system, are reported to the EA.

Irrespective of the daily count rate, all charcoal packs are replaced weekly. Each is then analysed by gamma spectrometry. Positive I-131 results are decay corrected to the mid-point of the sampling week. The results are multiplied by the sample fraction ratio for the system and the four (or five) weekly results obtained in the month are summed to give the monthly total I-131 discharge for each system. These figures are reported to the EA every month.

The total figures above are summed to give the overall monthly total for I-131 discharged. This latter figure, together with the calendar quarter and rolling 12 months totals, are also reported to the EA every month.

7.2.6 Particulates

Particulate discharges are sampled by passing a representative fraction of each discharge gas stream through a filter paper, which is then measured for beta activity. The capability exists to measure alpha emitting radionuclides associated with the particulate matter collected by the filter paper if required. The blowdown system is sampled continuously when the blowdown route is in service. All ventilation systems are sampled continuously with the exception of HV13, which is only sampled when the system is in service. Samples are normally changed and analysed 3 times per week.

Sample filter papers are assessed by a single count carried out on a radon compensated counter within 24 hours or against Cl-36 standards by an initial and final count in a non compensated counter. The final count is carried out after 72 hours to allow naturally occurring radon daughter products to decay. The samples from each system are bulked and retained for a period of two months prior to disposal.

For each system the 72-hour activity results are recorded on the monthly summary sheet. Sample activities are multiplied by the appropriate sample fraction ratio to calculate the activity discharged via each system. At the end of each month the total and maximum & minimum discharge in any sampling period, for each system, are reported to the EA.

The total figures above are summed to give the overall monthly total for particulate beta discharged. This latter figure together with the current calendar quarter and rolling 12 months totals, are also reported to the EA.

7.2.7 Recording of results

Recording of results, measurement error handling, minimum detectable activities, etc. are presented in Appendix 8.2.

7.2.8 Reporting of results

All results obtained are reported monthly to the EA. Reporting templates are presented in Appendix 9.2.

7.2.9 Calibration standards and frequencies

- Calibration standards

Radionuclides analysed for the purpose of the Authorisation are measured against appropriate calibration standards as identified in the text. Gamma spectrometers are calibrated against mixed nuclide standards. All standards are traceable to National Standards (EU) or to the National Bureau of Standards (USA).

- Calibration frequencies

Both plant and laboratory gamma spectrometers are check calibrated every 2 years. Laboratory systems are checked daily to ensure parameters are not drifting out of specification.

Liquid Scintillation Counters are calibrated annually using quenched standards. Check sources of unquenched standards are counted at frequent intervals.

Beta Particulate Counters are calibrated prior to use.

7.3 Liquid discharges

7.3.1. Discharge systems

The approved systems for the routine disposal of liquid radioactive wastes are the Final (monitoring) Delay Tank (FDT) and the Tritiated Water Storage Tank (TWST) systems which both discharge direct to the Cooling Water Outfall (CWO) as specified in the Certificate of Authorisation.

Discharges from certain other systems or abnormal events such as the contamination of buildings or roadways may result in the incidental discharge of liquid radioactive waste via the surface water drains to the CWO.

- FDT System

The FDT system receives drainage and wash water from all the reactor's Controlled Areas via the Active Effluent Water treatment Plant (AEWTP).

In the AEWTP effluent is treated by filtration and then held prior to discharge in one of four FDT, each of $36m^3$ capacity. When a tank is full the contents are re-circulated to ensure thorough mixing and a pre-discharge sample is taken for analysis. Once approved for disposal the tank contents are discharged to sea via the CWO. A proportional sample of all FDT discharged is taken from the discharge line during disposals. Up to 5 FDT discharges may occur in any day.

Should the tank contents be unsuitable for disposal, provision exists for the re-circulation of the liquor through the AEWTP filters and/or ion exchange units.

- TWST System

The TWST system receives water exclusively from the Reactor Gas Dryers (RGD). Effluent from the RGD is collected in two storage tanks of capacity 4.5 m^3 each. When either tank is full the contents are re-circulated to ensure thorough mixing and a pre-discharge sample is taken for analysis. Once approved for disposal the tank contents are discharged to sea via the CWO. Up to 4 TWST discharges may occur per month.

- Incidental Discharges

Incidental discharges of liquid radioactive waste may arise from systems such as the steam generation system or from abnormal events such as the contamination of buildings or roadways. Such discharges will be to plant or surface water drains other than those feeding the FDT system described above, and thence to sea via the CWO.

7.3.2 Control of discharges

- FDT System

The FDT system is protected from inadvertent discharges by an interlock system, requiring key exchanges at each stage of the following process.

Before discharge a FDT tank is isolated from the AEWTP and re-circulated for a period of 2 hours to ensure thorough mixing of the tank contents. A representative sample is then taken and assessed for activity. If this result is satisfactory, the Health Physics staff confirms compliance with the Certificate of Authorisation and permission to discharge the waste will be given by a Duly Authorised Person (DAP).

FDT activities above a pre-determined action level or anomalous results will be referred to an Accredited Health Physicist who will advise the DAP on possible actions to be taken.

- TWST System

The TWST system is protected from inadvertent discharges by an interlock system, requiring key exchanges at each stage of the following process.

Before discharge of a TWST the tank is isolated from the RGD and re-circulated for 2 hours to ensure thorough mixing of the tank contents. A representative sample is then taken and assessed for activity. If this result is satisfactory, the Health Physics staff confirms compliance with the Certificate of Authorisation and permission to discharge the waste will be given by a Duly Authorised Person (DAP).

Anomalous results will be referred to an Accredited Health Physicist who will advise the DAP on possible actions to be taken.

- Incidental Discharges

Controls on incidental discharges will be established as necessary to ensure that such discharges are assessed and proceed to sea via the CWO. During abnormal events resulting in the contamination of buildings or roadways, controls will be established to limit the spread of contamination.

7.3.3 Sampling and analysis of FDT discharges

- Pre-discharge samples

A 1000 ml sample is taken from each FDT during re-circulation when the mixing period of 2 hours has elapsed. This predetermined time allows adequate mixing of the contents prior to sampling. The analysis of this sample is used to sanction the discharge of the FDT.

Pre-discharge samples are analysed by liquid scintillation counting (LSC) for ‘soft’ (tritium only) and ‘hard’ (other weak beta emitting nuclides) activity. The LSC counter is calibrated against C-14 and Fe-55 standards with quench correction.

Results as summed ‘hard’ and ‘soft’ activity are recorded on individual FDT discharge certificates.

- <u>Daily proportional samples</u>

Daily proportional samples are taken from the FDT discharge lines by proportional samplers collecting a sample of 32 ml per m^3 discharged.

In the event of failure of the proportional sampler, a back-up sampling system is provided on each discharge line in the form of a ‘drip’ sampler. Failure of the proportional sampler will however automatically interrupt the discharge procedure. Furthermore additional discharge interrupting alarms are present along the discharge line, downstream of the sampling device.

Daily samples are analysed as follows, within 14 days of the day of discharge:

- Tritium

A portion of the daily sample is distilled and the distillate analysed for tritium by LSC. The counter is calibrated against a tritium standard with quench correction.

- Cobalt 60

A 250 ml portion of the daily sample is analysed by gamma spectrometry, reporting cobalt 60 (Co-60) activity.

- Total activity excluding tritium

A 10 ml portion of the daily sample, treated with 6M nitric acid and 30% volume hydrogen peroxide, is evaporated to dryness to remove tritium. The residue is re-dissolved in 0.1M nitric acid and analysed by LSC for summed ‘hard’ and ‘soft’ activity. The counter is calibrated against C-14 and H-3 (or Fe-55) standards with quench correction.

- <u>Retained samples</u>

A portion of each daily sample is used to prepare samples for retention as follows:

- A 430 ml portion of each daily sample, made up to 500 ml with 2M nitric acid, is retained for a period of six months.

- A further 2.5% of each daily sample for the calendar quarter is aggregated and stabilised with 21 of 2M nitric acid to prepare an acidified bulk sample representative of FDT discharges for the quarter. A 500 ml portion of this sample is retained by the station for a period of six months from the end of the quarter of collection. The remainder is supplied to the company’s contract laboratory.

- <u>Monthly bulk samples</u>

Monthly bulk samples will be analysed for S-35 within 14 days of the end of the calendar month in which the discharges occurred.

A 20 ml portion of the monthly bulk, treated with 6M nitric acid, 100% volume hydrogen peroxide and sulphide carrier, is evaporated to dryness to remove tritium. The residue is re-dissolved in concentrated hydrochloric acid, diluted and the sulphate content precipitated by addition of barium chloride. The precipitate is suspended in gel scintillant and analysed for S-35 by LSC. The counter is calibrated against a precipitated S-35 standard with quench correction.

- <u>Summary record of discharges</u>

The FDT section of the monthly summary record of discharges is compiled as follows:

- Daily figures for FDT tritium, cobalt-60 and ‘total activity excluding tritium’ discharges are determined from the analysis of daily samples and summed for the month.

- The FDT S-35 discharge for the month is determined from the analysis of the monthly bulk sample.

- The FDT ‘other radionuclides’ discharge for the month, which is total activity excluding tritium, S-35 and Co-60, is determined by subtraction of the monthly total S-35 and Co-60 results from the month's 'total activity excluding tritium' figure.

- Quarterly bulk samples

As referred to in the Implementation Document, acidified quarterly bulk samples are analysed for tritium, Co-60 and total activity excluding tritium within the sixth week of the end of the calendar quarter in which the discharges occurred by both the site and the company's contract laboratory. Analysis methods are similar to those used for FDT daily samples. The results are used to provide quality assurance checks on the results of the routine analytical programme.

7.3.4 Sampling and analysis of TWST discharges

- Pre-discharge samples

A 150 ml sample is taken from each TWST during re-circulation when the mixing period of 2 hours has elapsed. This predetermined time allows adequate mixing of the contents prior to sampling. Because of the high specific activity of gas drier liquor a 1 ml portion of this sample is normally diluted with a 0.04% sodium sulphide carrier solution to prepare a 1:1000 dilution sample of the original liquor for analysis.

The 1:1000 dilution sample is analysed as follows:

- Tritium and S-35

By LSC before the tank is discharged. The result of this analysis is used to sanction the discharge of the TWST. The counter is calibrated against tritium and C-14 standards with quench correction.

- Tritium, S-35 and Other Activity

Re-analysis for tritium and S-35, then analysed for total activity of energy greater than S-35 by LSC within 14 days of taking the sample. The counter is calibrated against tritium, C-14 and strontium/yttrium 90 standards with quench correction.

- Co-60

The remainder of the undiluted TWST sample is used to determine Co-60 by gamma spectrometry, within 14 days of taking the sample.

- Retained samples

A portion of each 1:1000 dilution sample is used to prepare samples for retention as follows:

- The remainder of each 1:1000 dilution sample is retained for a period for six months.

- 20 ml per m^3 discharged of each 1:1000 dilution sample for the calendar quarter, is aggregated to prepare a bulk sample representative of TWST discharges for the quarter. 20 ml of the bulk sample is retained for 6 months; the remainder is supplied to the company's contract laboratory.

- Summary record of discharges

The TWST section of the monthly summary record of discharges is compiled as follows:

- Individual TWST figures for tritium, S-35 and Co-60 are determined from the post discharge analysis of the 1:1000 dilution sample and the undiluted TWST liquor as described above and summed for all TWST discharges in the month.

- Individual TWST figures for 'other activity' are determined by subtraction of Co-60 results from those for 'total activity of energy greater than S-35' and summed for all TWST discharges in the month.

- Quarterly bulk samples

Quarterly bulk samples are analysed for tritium, S-35, Co-60 and total activity of energy greater than S-35 within one month of the end of the calendar quarter in which the discharged occurred. Analysis is by methods for individual TWST samples as described above.

7.3.5 Incidental liquid discharges

- Samples

In the event of a controlled discharge of incidental liquid radioactive waste, where practicable representative samples of at least 1 litre will be taken from the most appropriate sample location both before the waste is discharged and during discharge. In the event of an uncontrolled discharge of incidental liquid radioactive waste that precludes the taking of pre-discharge and discharge samples, the results of routine analyses of samples from the relevant system will be used to estimate the activity discharged.

Samples taken in association with incidental discharges of liquid radioactive waste will be analysed within 14 days of the taking of the sample for the radionuclides specified in the Schedule to the Authorisation (tritium, S-35, Co-60 and 'other activity'). Samples taken in association with incidental discharges will be analysed by appropriate methods (normally those described for the analysis of daily FDT samples above).

In the event of incidental liquid effluent arisings sampling will cease when the incident is over, the release mechanism is understood and when there is enough information to be able to quantify the discharge.

- Retained samples

Samples of incidental liquid radioactive waste arisings will be retained for 6 months. Where appropriate, a number of samples associated with an incidental discharge may be combined into a single bulk sample representative of the discharge.

- Summary record of discharges

The occurrence of incidental liquid radioactive waste discharges will be noted in the 'comments' section of the monthly summary record of discharges. The results of the activity assessment of such discharges for tritium, S-35, Co-60 and 'other activity' will be included in the summary record as appropriate.

7.3.6 Recording of results

Recording of results, measurement error handling, minimum detectable activities, etc. are presented in Appendix 8.2.

7.3.7 Reporting of results

All results obtained are reported monthly to the EA. Reporting templates are presented in Appendix 9.2.

7.3.8 Calibration standards and frequencies

As described under section 7.2.9 above.

8. VERIFICATION ACTIVITIES - RADIOACTIVE DISCHARGES

8.1 Dungeness A – aqueous discharges

8.1.1 Monitoring systems – verification activities

The verification team visited:

- The FDT tanks and associated monitoring and sampling provisions.
- The CMT tanks.

8.1.2 Monitoring systems – verification findings and recommendations

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as:

- Summarised in section 6.3 above.

- Described in the operator's Control Management Procedure numbers MCP 016 and MCP 16/04 [refs. 30 and 31].
- Further detailed in the Health Physics working instruction number HPI 04/03 [ref. 33].

The presence of interlock and alarm systems was also verified and checked against Plant Item Operating Instruction number PIOI V19 [ref. 46].

The verification team considers the monitoring and sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems.

The verification team considers that discharges of liquid radioactivity are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document; the verification activities performed do not give rise to a specific recommendation.

8.1.3 Effluent laboratories – verification activities

The verification team visited the laboratory where it checked:

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

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

8.1.4 Effluent laboratories – verification findings and recommendations

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:

- Summarised in section 6.3 above.
- Detailed in the Health Physics working instruction number HPI 04/03 [ref. 33].

All relevant working instructions covering sample management (handling, measurement, reporting of results, proper use of equipment) are present in the laboratories in electronic format. Document control procedures stipulate that circulating hardcopies of working instructions are prohibited. The latest approved versions of these instructions are accessible (read-only mode) on every laboratory PC (local area network). However, the verification team noted the complexity and therefore the user-unfriendliness of the pathway that leads to the instructions.

The verification team noted that room for improvement is available with respect to the principle of having working instruction at arms-length and thus recommends the operator to optimise, in the framework of general quality control, the current unsatisfactory level of accessibility of its electronically archived working instructions.

The verification team noted a discrepancy between working instruction HPI 04/03 'Analysis of liquid effluents' [ref. 33], and the Implementation Document [ref. 47]. The definition of the period within which samples must be analysed differs markedly: in practice the operator abides by the time constraint of 14 days set be the Implementation Document; however, the working instruction requires samples to have been measured within 72 hours. It was also noted that the Implementation Document pre-dates HPI 04/03. Operators may use more restrictive rules than imposed by law but should then ensure that these internal rules are abided by, the more so since internal rules are compiled in written instructions with the intention to ensure quality control.

The verification team noted, when auditing source documents at the laboratory, that post-discharge proportional sample results (FDT tanks) had been substituted with pre-discharge results for a series of discharges that occurred in May 2000. Contrary to the ruling of the Certificate of Authorisation and the Implementation Document, the pre-discharge sample results were officially declared to the regulator through the so-called 'Monthly Return' document. At laboratory staff level this substitution had been performed because of 'temporary technical problems with sample preparation', more in particular regards Cs-137 assay. Laboratory staff autonomously decided to use pre-discharge samples for Cs-137 assessment but without informing their superiors. This eventually resulted in the responsible manager to sign off the Monthly Return unknowingly and represents a departure from quality assurance and control standards.

The verification team recommends the Environment Agency to ensure that operators duly report and justify any departure from the rulings and principles laid down in the Certificate of Authorisation and detailed in the Implementation Documents.

The verification team recommends the Environment Agency to audit the operator's Management Procedures and Health Physics Instructions at set intervals in order to check the compliance of these quality control and assurance documents with the Certificate of Authorisation and related Implementation Documents.

The verification team checked the correspondence between the operator's Monthly Returns and the source spreadsheet used to compile the former. The team performed this activity to satisfaction on the Monthly Returns for April 1998.

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

The verification team considers the sample measurement devices present in the laboratory to be adequate. Quality control on the equipment (calibration frequencies, sources and standards, record keeping) is assured by the implementation of written operation and calibration procedures [refs. 41-43].

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

8.2 Dungeness A – gaseous discharges

8.2.1 Monitoring systems – verification activities

The verification team visited:

- The SCA vent stacks and associated sampling provisions.
- The sampling provisions of the RGC circuit and BD stacks.

It should be noted that each reactor unit has 2 separate RGC circuits 4 BD stacks. Due to time constraints the team chose to verify the sampling provisions on one of the twin reactor units and restricted its verification activities of the monitoring and sampling provisions to one coolant circuit and to one blowdown stack.

8.2.2 Monitoring systems – verification findings and recommendations

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as:

- Summarised in section 6.2 above.
- Described in the operator's Control Management Procedure numbers MCP 016 and MCP 16/05 [refs. 30 and 34].
- Further detailed in the Health Physics working instruction numbers HPI 03/01, 03/02 and 03/03 [ref. 35 to 37].

- The SCA vent stack sampling provisions.
  - Isokinetic sampling

During its visit the verification team noted the presence of two separate sets of sampling lines on each stack. The sampling devices were however connected to those lines that clearly were of a more recent manufacture. The verification team enquired if, for the more recent sampling lines, necessary provision had been taken to ensure isokinetic sampling. The operator subsequently made the relevant plant item drawings and related calculations available for consultation. From these it transpired that isokinetic sampling had been ensured back in 1993 when the new sampling lines were fitted in order to comply with new rulings set out in RSA93.

The verification team considers that discharges of airborne radioactivity at the vent stacks are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document.

- Iodine-131 sampling

The sampling devices (mobile trolleys) that continuously sample the SCA for aerosols have been designed in such a way that specific sampling for iodine-131 is also possible. Routine sampling for I-131 is however not performed as it is deemed only necessary to implement such sampling in case of well-defined emergencies (details in section 6.2.6 above). A second reason raised for not routinely sampling for I-131 is that Magnox reactors, under normal operational conditions, do not release this radionuclide.

The verification team noted, would such an emergency occur, that charcoal 'maypack' filters are not available at arms-length of the sampling devices. Furthermore it was noted that 'maypacks' have to be prepared at the Denge environmental lab outside the site's perimeter; a stock of ready-to-use 'maypacks' not being available. It may therefore take the operator an undefined amount of time before the sampling device for I-131 becomes operational. Also, even though the releases of iodine under normal operations is believed not to occur, it should be considered if regularly monitoring I-131 would not be useful, be it only to effectively confirm the absence of such releases.

The verification team recommends the Environment Agency to consider the implementation of regular monitoring of I-131 in gaseous discharges from Magnox power stations.

- The RCG circuit and BD stack sampling provisions.

  - The RCG sampling trolley

During its verification activities the team noted that the sampling trolley is suffering from minor but recurrent operational failures. These failures do however not appear to affect the effluent sampling programme. Faced with this shortcoming of the reliability of the equipment, the operator took the decision to replace the existing sampling trolleys with modern equipment. Replacement is planned to take place during the year 2001. The verification team fully endorses such a replacement.

The verification team considers that the control of airborne radioactivity in the Reactor Coolant Gas Circuit is broadly satisfactory. However, the verification team recommends the Environment Agency to ensure that the ongoing lack of confidence in the continuous availability of the RCG sampling devices does not negatively affect the statutory sampling programme for gaseous discharges and associated analytical results.

  - The BD sampling provisions

The verification team considers that the discharges of airborne radioactivity via the Blowdown Systems are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document; the verification activities performed do not give rise to a specific recommendation.

8.2.3 Effluent laboratories – verification activities

The verification team visited the laboratory where it checked:

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

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

8.2.4 Effluent laboratories – verification findings and recommendations

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:

- Summarised in section 6.2 above.
- Detailed in the Health Physics working instruction numbers HPI 04/01 [ref. 40].

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

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

At the station's archive, known as the Document Control Centre (DCC), the verification team verified the concordance between the operator's official transmission of discharge data to the regulator (the so called 'monthly returns') and the discharge data as published by the authorities. More in particular the RIFE-4 report covering the year 1999 [ref. 18] was submitted to this scrutiny. Some minor discrepancies due to rounding adjustments are present in the report, but the verification team deemed these to be acceptable because of their low level of significance.

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

The verification team also checked the correspondence between Monthly Returns and the source spreadsheets used to compile the former. The team performed this activity to satisfaction on Monthly Returns for April 1998 and August 1999.

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

8.3 Dungeness B – aqueous discharges

8.3.1 Monitoring systems – verification activities

The verification team visited:

- The FDT tanks and associated sampling provisions.
- The TWST tanks and associated sampling provisions.

8.3.2 Monitoring systems – verification findings and recommendations

During the course of the visit the verification team confirmed the existence and functionality of all the monitoring and sampling provisions as:

- Summarised in section 7.3 above.
- Described in the operator's Health Physics Technical Report number DUNB/R/245C/RH011 and Management Control Procedure number MCP 16 [refs. 50 and 53].
- Further detailed in the Health Physics working instruction number HPWI H04 [ref. 57].

The verification team considers the monitoring and sampling equipment for liquid effluents to be adequate and the programme of liquid effluent sampling to be satisfactory. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems.

The verification team considers that discharges of liquid radioactivity are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document; the verification activities performed do not give rise to a specific recommendation.

8.3.3 Effluent laboratories – verification activities

The verification team visited the laboratory where it checked:

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

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

8.3.4 Effluent laboratories – verification findings and recommendations

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:

- Summarised in section 7.3 above.
- Detailed in the Health Physics Working Instruction numbers HPWI H01, H02 and H03 [refs. 54, 55 and 56].

All relevant working instructions covering sample management (handling, measurement, reporting of results, proper use of equipment) are present in the laboratories in electronic format and as hardcopy.

The verification team checked the correspondence between the operator's Monthly Returns and the source spreadsheet used to compile the former. The team performed this activity to satisfaction on the Monthly Returns for November 1998 and September 2000.

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

The verification team noted that quarterly bulk samples are split between operator and regulator. The regulator has the bulk sample analysed by its contracting laboratory in order to obtain independent confirmation of the operator's declared result. As both laboratories use identical analytical methods to measure the sample, results could be used to assess the operator's laboratory performance. In fact the aliquot of the bulk sample as retained by the operator for analysis is known as the 'station QA check'. The regulator omits, however, to inform the operator of the results of the independent analysis. The opportunity to provide the operator with valuable feedback is lost by this omission.

The verification team recommends the Environment Agency to consider transmission of the results of their independent effluent analysis programme to the operator concerned, more in particular with respect to bulk samples, quarterly or otherwise, so as to provide the operator with a valuable means of performing analytical quality assurance checks.

The verification team considers the sample measurement devices present in the laboratory to be adequate. Quality control on the equipment (calibration frequencies, sources and standards, record keeping) is assured by the implementation of written operation and calibration procedures.

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

8.4 Dungeness B – gaseous discharges

8.4.1 Monitoring systems – verification activities

The verification team visited:

- The Blowdown system.
- The active areas HV1A.
- The Reactor Man Access HV13.
- The Irradiated Fuel Disposal Facility Stack.

8.4.2 Monitoring systems – verification findings and recommendations

The verification team considers that the discharges of airborne radioactivity via the 4 visited outlet points are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document; the verification activities performed do not give rise to a specific recommendation.

The verification team however noted that the EA does not systematically perform independent sampling of gaseous effluents.

The verification team recommends the Environment Agency to consider the implementation of independent sampling of radioactive effluents to enhance the current programme of independent analysis of radioactive effluents.

8.4.3 Effluent laboratories – verification activities

The verification team visited the laboratory where it:

- Checked the facilities and equipment.
- Performed spot-checks on the availability of working instructions and other quality-assurance related documents.
- Performed spot-checks for the whole process from sampling documentation to transmission of the results of 2 randomly selected samples (air monitoring and Blowdown system for the reporting periods of November 1998 and October 1999).

8.4.4 Effluent laboratories – verification findings and recommendations

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

9. THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

9.1 Introduction

9.1.1 Aims

One of the conditions of the authorisation to discharge radioactive effluents and wastes is that an environmental monitoring programme must be carried out to determine the effects of these discharges on the environment. The primary purpose of Environmental Monitoring Programmes (EMP) is to monitor the safety of the general public and critical groups. In order to assess the total radiation dose received by a member of the public and for comparison with dose limits, samples are taken from the environment and the food chain. In this context the term sampling includes the collection of samples from the environment for laboratory analysis (which is mainly directed at food pathways), and also selective direct measurements of dose rates in the environment to assess external exposure pathways. Most sampling and direct monitoring is conducted in the site's immediate vicinity.

The EMP also provides reassurance that permitted discharges are estimated correctly and that unusual discharges to the environment are recognised early.

9.1.2 Responsibilities

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

In parallel to the DSP the competent authorities run complementary environmental monitoring programmes, partly with the aim to verify the operator's DSP results. Under the lead of the Department of the Environment, Trade and Industry (DETR), the responsibility for carrying out the EMP is split between the Environment Agency (EA) for the non-food pathways and the Food Standards Agency (FSA) for the food chain pathways. Both agencies subcontract several laboratories to perform the analyses of their respective EMP.

9.2 Dungeness power stations

9.2.1 Introduction

Dungeness B staff carries out the DSP sampling and analyses on behalf of both Dungeness A and Dungeness B companies, BNFL Magnox Generation and British Energy Ltd respectively. The Central Radiochemistry Laboratory (CRL, a BNFL subsidiary) carries out further analysis.

The programme defines levels of radioactivity in the environment for which immediate notification of the regulator is compulsory.

9.2.2 The district surveillance programme

The DSP focuses on two main areas, terrestrial and marine monitoring, with the objective of quantifying potential doses to individuals. This is undertaken through the direct measurement of dose rates and through the analysis of environmental samples. Details of the DSP are given in Appendices 10 and 11.

The media sampled are:

- Milk (from two farms within a 15 km radius).
- Herbage (from 8 farms adjacent to site and from 4 farms within a 10 km radius).
- Sediments (adjacent to site and from 4 beaches within a 15 km radius: Rye Harbour, Camber Sands, Greatstone, Lydd-on-Sea and The Pilot PH).
- Fish, shrimp and molluscs (locally caught).
- Domestic water (from 4 points within the Denge Wells water extraction system).

Terrestrial samples: except for milk, samples will be retained for one year from the end of the year of collection. Milk samples are not retained after analysis by CRL.

Aquatic samples: portions of these samples will be retained for two years from the end of the year of collection, normally in the form of the dried material.

9.2.3 Sampling, sample preparation, sample measurement

The relevant procedures are laid down in Health Physics working instruction HPWI D01 to HPWI D25. See Appendix 1, references 83 to 106.

9.2.4 Reporting and quality control

Results of the measurements and analyses undertaken are reported on summary record forms. Record forms are dispatched quarterly before the end of the subsequent quarter. Without the agreement of the EA, no change to the format of the summary records will be made without revision of the document.

Records are retained until such time as agreed by the EA.

9.3 Environment Agency

9.3.1 Introduction

The EA carries out the following routine monitoring programmes:

- Monitoring of the environment, primarily in the vicinity of nuclear sites.
- Monitoring of effluent samples provided by nuclear site operators [5].
- Waste quality checking of solid low level radioactive waste disposals [6].
- Air and rainwater in the United Kingdom (on behalf of DETR to fulfil Euratom Treaty Article 35 & 36 requirements).
- Drinking water sources in England and Wales (on behalf of DETR to fulfil Euratom Treaty Article 35 & 36 requirements).

The EA National Compliance Assessment Service (NCAS) manages all the EA programmes.

The monitoring programmes are specified through liaison with the EA Officers responsible for the premises authorised, Regional Monitoring Liaison Officers (RMLO) and NCAS Programme Managers. The programmes are tailored to the individual site authorisations with regard to what types of samples are collected and nuclides analysed. However where there is commonality the programmes are designed to be consistent. The required samples, nuclides and detection limits are specified in the monitoring programme contracts.

5 Summarised in Appendix 14.
A flow chart of both environmental and effluent monitoring programmes is given in Appendix 15.

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

9.3.2 The environmental monitoring programme

The EA undertakes a programme of monitoring of radioactivity in the environment, where the radioactivity could lead to exposure of the public from non-food pathways such as might arise from the occupation of beaches, riverbanks or other areas. This environmental monitoring programme consists of surveys of gamma dose rates and contact beta/gamma dose rates at specified locations and laboratory analysis of radionuclide concentrations in environmental samples taken from specified locations in the vicinity of nuclear sites and other industrial premises. Samples are also taken from surface waters, some of which are used as sources of potable water.

The EMP around Dungeness is summarised in Appendix 12.

The selection of sampling or measurement points is based on a combination of factors, including measured dose rates and the occupancy of the areas. Local habit surveys are also considered when defining the EMP. The majority of monitoring is focused around the nuclear licensed sites.

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

The majority of the methods employed are accredited by the UK Accreditation Service (UKAS) and are summarised in Appendix 13.

9.3.3 Ambient dose

Measurements of gamma dose rates above beach and river bank areas are made by measuring the absorbed dose rate in air (µGy/h) one metre above ground.

Contact beta/gamma monitoring of debris at the most recent strand line on the beach or riverbank is also carried out.

Currently this part of the EMP is carried out by ICI Synetix Services (Cleveland), in accordance with EA specifications.

9.3.4 Air and rainwater

Currently NNC Ltd at the Winfrith Technology Centre (Dorchester) undertakes air and rainwater analysis.

The seven sampling locations in the UK are Chilton (Oxfordshire), Aberporth (Dyfed), Conlig (Co Down, NI), Dishforth (Yorkshire), Eskdalemuir (Dumfrieshire), Lerwick (Shetland) and Orfordness (Suffolk). Airborne particulate material is sampled continuously at a height of about one metre above ground level. Filters are changed weekly at each location. The closest stations to Dungeness are Chilton and Orfordness.

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

9.3.5 Drinking water sources

Regular monitoring of radioactivity in water sources (rivers, reservoirs and boreholes) used for the supply of drinking water has also been carried out for many years in the UK. The water companies provide samples of water for analysis currently undertaken by Harwell Scientifics Ltd using methods that are mostly accredited by UKAS. These results also provide information to the water companies on the activity concentrations of radionuclides in raw water sources and supplementary data to the Agency on exposure of the public.

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

9.3.6 Reporting and quality control

The contractors who undertake the EA EMP have quality management procedures in place (ISO 9001) to provide an audit trail of results through to transmission to the EA. These procedures form part of the laboratories' UKAS accreditation. Results are provided as paper reports to the EA. NNC Ltd has also been contracted to enter the monitoring data into an MS Access database developed by AEA Technology. This database provides the repository for EA monitoring data.

The Agency's contract laboratory holds a database of past results for all locations and determinants on the EMP. The database holds results dating back at least 5 years, except for locations that have been more recently added to the programme. Each calendar quarter, the contract laboratory inputs the new results into the database and compares the results with historical data. The contract laboratory determines whether the new results are in any way noteworthy or significant. Where results are considered 'highly significant' the contract laboratory notifies the Agency Programme Manager immediately.

In the case of results which are not considered 'highly significant' but which are nevertheless regarded as 'interesting' or 'noteworthy' these results are highlighted by the contract laboratory in a quarterly 'comments and trends' report provided to the EA. This report highlights the results in text and/or graphs comparing the recent result with historical data at the same location for the same determinant(s). This reporting procedure also applies to results that are significantly lower than historical data.

The EA publishes the results from the monitoring programmes in annual reports, 'Radioactivity in the Environment'.

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

9.4 Food Standards Agency

9.4.1. Introduction

The main aim of the EMP is to monitor the diet of consumers who live or work near nuclear sites in order to estimate exposures for those small groups of people who are most at risk from disposals of radioactive waste. In the aquatic environment, the pathways that are the most relevant are the ingestion of seafood and freshwater fish, drinking water and external exposure from contaminated materials. In the terrestrial environment they are the ingestion of terrestrial foods, inhalation of airborne activity and external exposure from material in the air and deposited on land. The main thrust of the monitoring is therefore directed at a wide variety of foodstuffs and measurements of external exposures on the shores of seas, rivers and lakes. It also includes some key environmental indicators so that levels found in the environment can be put in an historic context.

The description of the work undertaken can be conveniently divided into two categories: aquatic and terrestrial. The first deals with contamination in or near the sea, rivers and lakes and acts as a check on disposals of liquid wastes. The second deals with contamination on land, which is dominated by disposals to the atmosphere.

9.4.2 The aquatic programme

The overall scope of the aquatic programme is summarised in Appendix 16; the aquatic programme at Dungeness is summarised in Appendix 17.1.

The main components are sampling and analysis of a range of seafood and indicator materials. The sampling programme is guided by the use of habit surveys. The latest aquatic habit survey around Dungeness was undertaken in 1999 and the preliminary results were used to update the 2000 programme. In addition to the habit surveys the programme is kept under annual review and changes are implemented if necessary. For instance the 1999 habit survey showed that spider crabs are no longer fished in the area, but edible crabs are being landed and hence were included in the 2000 programme. It was also found that cuttlefish were being eaten so these were added to the programme in 2000.

9.4.3 The terrestrial programme

The main focus of this programme is the sampling and analysis of foodstuffs that may be affected by disposals to atmosphere, although in some cases where food availability is limited, environmental indicator materials such as grass are monitored.

The overall scope of the terrestrial programme is summarised in Appendix 16; the terrestrial programme at Dungeness is summarised in Appendix 17.2.

9.4.4 General diet

The purpose of the general diet surveys is to provide information on radionuclides in the food supply to the whole population, rather than to those in the vicinity of particular sources of contamination such as the nuclear industry. This programme provides background information that is useful in interpreting site-related measurements and also helps ensure that all significant sources of contamination form part of the site-related programme. Representative mixed diet samples are collected from regions throughout the United Kingdom. In England and Wales the samples are derived from the FSA Total Diet Study (TDS). Normal culinary techniques are used in preparing samples (e.g. removal of outer leaves) and samples are combined in amounts that reflect the relative importance of each food in the average United Kingdom diet. These samples are analysed for a range of contaminants including radionuclides. Part of this data is also supplied to the European Commission (EC) in support of the Euratom Treaty, under the terms of article 36 thereof.

Further background information on the relative concentrations of radionuclides is gained from the sampling and analysis of foods, particularly milk, crops, bread and meat.

Milk sampling takes place at dairies throughout the United Kingdom. Samples are taken monthly and some of the results are reported to the EU to allow comparison with those from other member states.

9.4.5 Sample analysis

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

- Gamma-ray spectrometry.
- Radiochemical methods.

The former is a cost-effective method of detecting a wide range of radionuclides commonly found in radioactive wastes and is used for most samples. The latter comprise a range of analyses involving chemical treatments to isolate the radionuclides under study. They are sensitive but costly methods. They are therefore only used when there is clear expectation that information is needed on specific radionuclides that are not detectable using gamma spectrometry.

Two laboratories analysed samples from Dungeness. Their main responsibilities were as follows:

- CEFAS (Centre for Environment, Fisheries and Aquaculture Science) for the analysis of dry cloths and aquatic samples.
- VLA (Veterinary Laboratory Agency) for gamma spectrometry and radiochemistry (excluding total uranium analysis) of terrestrial samples.

Each laboratory operates a quality control procedure to the standards required by the FSA, involving regular calibration of detectors and intercomparison exercises with other laboratories.

Corrections are made for the radioactive decay of short-lived radionuclides between the time of sample collection and measurement in the laboratory. This is particularly important for sulphur-35 and iodine-131. Where bulking of samples is undertaken, the date of collection of the bulked sample is assumed to be in the middle of the bulking period. Otherwise the actual collection date for the sample is used. In a few cases where short-lived radionuclides are part of a radioactive decay chain the additional activity (‘in-growth’) produced as a result of radioactive decay from their parent radionuclides after sample collection is also considered. Corrections to the activity present at the time of measurement are made to take this into account for the radionuclides protactinium-233 and thorium-234.

The analysis of foodstuffs is carried out on that part of the sampled material that is normally eaten. The shells of shellfish and the pods of legumes are discarded before analysis. Foodstuff samples are prepared in such a way so as to minimise losses of activity during the analytical stage. Most shellfish samples are boiled soon after collection to minimise losses from the digestive gland. For a few radionuclides, some activity may be lost in the cooking process during sample preparation. These losses reflect the effects of the normal cooking process for the foodstuff.

The methods of measurement used are summarised in Appendix 18.

9.4.6 Measurement of dose rate

Measurements of gamma dose in air over intertidal areas are normally made at 1 m above the ground using Mini Instruments environmental radiation meters type 6-80 with compensated Geiger-Muller tubes type MC-71. With certain key public activities, for example for people living on houseboats or for wildfowlers lying on the ground, measurements at other distances from the ground may be made. External beta doses are measured on contact with the source, for example, fishing nets, using Berthold LB 1210B contamination monitors. These portable instruments are calibrated against recognised reference standards.

9.4.7 Dry cloths

The dry cloth programme provides a simple and cheap method of sampling airborne radioactive contamination around some of the major nuclear licensed sites. The dry cloth assembly consists of a v-shaped, dust retentive cloth mounted to pivot on a 2-metre rod. The assembly is set up in a relatively exposed, but secure area and is free to turn in the wind to maximise collection. The cloths are changed each month and analysed for alpha, beta and gamma activity. Around 2000 cloths are analysed each year in the UK. Each set of results is carefully examined so that further sampling or investigation at the site can follow up any unusual levels of activity.

9.4.8 Reporting and quality control

The procedures for the VLA to notify FSA of unusually high analytical results are set up as 'warning levels' that are used by VLA to notify FSA. There are separate levels for milk and non-milk samples for each radionuclide in Bq/kg or in Bq/l. If a sample is over a warning level, VLA e-mails and faxes FSA requesting a confirmation. FSA will investigate at once using the form 'Samples Exceeding VLA Warning Level' and usually requesting a re-run of the analysis and notifying the EA and/or the nuclear site.

FSA also use 'trigger levels' for each radionuclide in each foodstuff based on 25% of the Generalised Derived Limit (GDL). If this trigger level is exceeded in any foodstuff FSA will investigate the cause as a matter of urgency.

The procedure for CEFAS to notify FSA of unusually high analytical results is similar to the procedure for the VLA.

The FSA publishes the results from the monitoring programmes in annual reports, 'Radioactivity in Food and the Environment' (RIFE). The results of the FSA programme are also available on the Internet.

The arrangements for the verification of the safe and accurate data transfer between and within the Veterinary Laboratory Agency [Radiochemistry Unit], the Food Standards Agency [Radiological Safety Unit [(7)]], and CEFAS [Environment and Food Safety Unit] are summarised in Appendix 19.

- The TRAMP database for the terrestrial programme

On behalf of the Radiological Safety and Nutrition Division of MAFF the VLA developed the Terrestrial Radioactivity Monitoring Programme database (TRAMP) in the early 1980s. After its establishment in 2000 the Radiological Safety Unit (RSU) of the FSA took over the responsibility for the database and the data contained within. Under instruction from the RSU the VLA continued to maintain the database and to use it for various inputs and data storage, including:

7 Formerly the Radiological Safety and Nutrition Division of MAFF.

- Logging in samples upon receipt from field staff, including generating Analytical Reference Numbers (ARN) so each sample has a unique code.
- Assigning required analyses for each sample.
- Analytical data entry.

Datasets from this database are transferred periodically to RSU (by e-mail and on diskette):

- Sampling data (Sample type, sampling date, sample location, name and address of sample owner, ARN, etc.).
- Analytical method employed.
- Results (values, errors, notes, etc.).
- Other relevant data.

Upon receipt at RSU both transferred datasets are subjected to quality control and assurance procedures and stored on a dedicated PC. When the data for a complete year have been entered and signed off by VLA, in agreement with their internal verification systems, a final disk is forwarded to RSU. There the contents of the disk are compared with the earlier datasets received. When satisfied that no discrepancies are present RSU forwards the yearly disk to CEFAS.

CEFAS extracts the data from the TRAMP database disk and reformats the data into the tables used for the RIFE report. Currently CEFAS do not use a comparison system to ensure the data transferred have not been corrupted. However, after reformatting for RIFE, the data are manually checked on hard copy by RSU staff. Discrepancies are reported to CEFAS, with a note sent to the RIFE co-ordinator as well. In case the discrepancy becomes subject of dispute between RSU and CEFAS the RIFE co-ordinator acts as arbitrator.

- <u>The LSDM database for aquatic programme</u>

The Liquid Sample Data Management (LSDM) database is maintained and operated by CEFAS (Lowestoft) under instruction from the RSU.

The annual aquatic surveillance sampling and analysis programme is defined by the Surveillance Schedule held on the LSDM system. This document is produced annually by CEFAS, defines sample type, location, sampling frequency, sample processing and analyses required and incorporates any changes derived from habit surveys or other sources. If required additional (unscheduled) samples may be added to the LSDM system during the year. The document is reviewed and approved by FSA.

Sampling is carried out according to the agreed schedule by CEFAS staff or designated collectors. Sample details are recorded on the packaging of all samples. On receipt at Lowestoft each sample is assigned a unique sample reference number by the LSDM. Sample logging is restricted to named individuals as part of the UKAS quality accredited system under which CEFAS operates in order to produce a verifiable audit trail from sample receipt to analytical results. SOP (Standard Operating Procedures) govern all stages from sample collection to final analytical result. All analyses are subject to UKAS accreditation, all assay results are also logged onto the LSDM and then validated by appropriate senior analysts before being released for general access to the system results archive. Individual results are also checked by comparison with similar previous results. Any apparently anomalous results ie high values or unexpected radionuclide types are flagged to the appropriate CEFAS contract leader and if verified the result is immediately reported to the relevant FSA contact.

Results archived onto the LSDM are currently reported via email to the FSA on a quarterly basis. Arrangements are in hand for RSU to have direct access to the LSDM.

CEFAS extract the data from the LSDM and reformat the data into the tables used in the RIFE report. CEFAS verifies the data by reference to previous results and discharges to the aquatic environment. If significant changes are noted, RSU are notified and further investigations take place before entries are confirmed in the tables for the RIFE report.

10. VERIFICATION ACTIVITIES - ENVIRONMENTAL MONITORING PROGRAMMES

10.1 Dungeness power stations

10.1.1 Verification activities

The verification team visited:

- The Dungeness Environmental Laboratory (known as the Denge Lab) where it checked:
  - Sample management (identification and registration procedures),
  - Sample preparation and measurement procedures,
  - Reporting and archiving of sample data,
  - Quality control procedures.
- Environmental sampling locations for domestic water, herbage, milk, marine sediment, marine biota, atmospheric dusts (dry cloth collectors). At all these locations the operator explained how statutory sampling procedures are implemented, a routine marine sediment sampling was performed. The team also visited a location where gamma doserate is surveyed, 3 dose rate measurements were taken.

10.1.2 Verification findings and recommendations

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

- Summarised in section 9.1 above and detailed in Appendices 10 and 11.
- Described in the operator's Health Physics Technical Report number DUNB/R/7930/RH020 [ref. 55].
- Further detailed in the Health Physics working instruction number HPWI D01 to D04 [refs. 83 to 86], D08 [ref.90], D11 to D16 [refs. 93 to 98], D18 [ref.100], D20 and D21 [refs. 102 and 103], D23 and D25 [refs. 105 and 106].

- The environmental laboratory

The verification team satisfactorily performed a series of spot-checks on historic samples (herbage 1995, molluscs 1996, milk 1997 and marine biota 2000 [1st quarter]) in order to verify the traceability of environmental data as officially published.

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

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

> *The verification team considers that the organisation and operation of the station's environmental monitoring laboratory to be excellent. High levels of quality assurance and control are in place. The verification activities performed do not give rise to any recommendation.*

The verification team noted that environmental samples for which individual assessment of specific nuclides is required are send to the CRL at Berkeley. The CRL has NAMAS/UKAS accreditation and is entitled to perform the radiochemical operations necessary for such assessments. A representative of the CRL gave a comprehensive presentation on the accredited analytical methods used for the assessment of S-35 and C-14 in herbage samples and results obtained.

> *Taking into account the restricted scope of this activity, the verification team has no further comments to make.*

- <u>The environmental monitoring programme</u>

The team observed that sampling procedures are performed in accordance with working instructions.

The team noted that 12 locations have been designated for the sampling of herbage as indicator medium. However, the verification team also noted that only one out of these locations is sampled in any given quarter. Every location is therefore sampled once every three years. It is the verification team's opinion that the sampling frequency in particular for 'inner' locations is too low in order to get comparable measurement results.

> *The verification team recommends the Environment Agency to improve the representativeness of the operator's herbage sampling by requiring yearly sampling of all locations on well-defined sampling spots.*
>
> *See also the recommendation drawn under section 10.3.2 - second hyphen.*

10.2 Environment Agency

10.2.1 Verification activities

The verification team:

- Checked the adequacy of the environmental monitoring programme.
- Verified the procedures that are initiated when unusual monitoring results occur.

10.2.2 Verification findings and recommendations

The EA environmental monitoring programme lacks quantitative assessment of aerosol-borne total beta activity and gammaspectrometric assessment of aerosol-borne radionuclides at ground level. The dry-cloth monitoring programme only allows for a qualitative assessment of airborne activity concentration.

> *The verification team recommends the EA to install medium velocity air samplers as collectors for representative sampling and quantitative assessment of aerosol-borne gamma/beta-emitting radionuclides resulting from atmospheric releases of activity. Such air sampler should be located at sites in the vicinity of the power stations.*

10.3 Food Standards Agency

10.3.1 Verification activities

The verification team restricted itself, due to restricted time available, to:

- Visit the Radiochemistry Unit of the VLA at Weybridge where samples from the FSA EMP are analysed. At the VLA, using a randomly chosen sample as lead (a Sea Kale sample taken week 20/2000; reference RNT 00T CDU 00120) the team verified the following:
  - Sample management (identification and registration procedures),
  - Sample preparation and measurement procedures,
  - Reporting and archiving procedures relative to sample data,
  - Quality control and assurance procedures.
- Visit the EMP sampling points around Dungeness:

- Dry cloth collector	Lighthouse T. Whitling	(FSA)
- Sea Kale sampling point	Lighthouse T. Whitling	(FSA)
- Marine sediments, E/SL 1	Dungeness	(Operator)
- Drinking water	Denge Wells	(Operator)
- Milk	A milk farm	(Operator & FSA)
- Herbage and core	Haffenden farm	(Operator)
- Sediment collector and radiation dose rate measurement, E/SL 9		(Operator)
- Sediment collection, E/SL 10	Rye Harbour	(Operator & FSA)
- Cockle collection site and fish catching area,	Lydd beach	(Operator)

10.3.2 Verification findings and recommendations

- The Veterinary Laboratory Agency.

The verification team noted the high standards by which the VLA operates as well as the excellence of its quality management system.

> *The verification team considers that the organisation and operation of the Veterinary Laboratory Agency to be excellent. High levels of quality assurance and control are in place. The verification activities performed do not give rise to any recommendation.*

- The sampling points

The FSA as well as the operator do not sample herbage as feeding stuff, only as an indicator. There are numerous grazing grounds for sheep in the vicinity of the Dungeness power stations.

> *The verification team recommends the FSA to consider implementing a sampling programme for herbage in case of sheep's meat and milk is consumed.*

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:

Operator's radioactive effluent monitoring and analytical laboratory

Dungeness A – liquid discharges

1. The verification team considers that discharges of liquid radioactivity are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems. The verification activities performed do not give rise to a specific recommendation.

Dungeness A – gaseous discharges

2. The verification team considers that discharges of airborne radioactivity at the Vent Stacks and Blowdown Systems are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems. The verification activities performed do not give rise to a specific recommendation.

3. Routine sampling for I-131 is not performed as it is deemed only necessary to implement such sampling in case of well-defined emergencies; Magnox reactors, under normal operational conditions, do not release this radionuclide. The verification team noted that, in case an emergency would occur, it would take the operator an undefined amount of time before the sampling device for I-131 would become operational. Even though the releases of iodine under normal operations is believed not to occur, it should be considered if regular monitoring of I-131 would not be useful, be it only to effectively confirm the absence of such releases.

The verification team recommends the Environment Agency to consider the implementation of regular monitoring of I-131 in gaseous discharges from Magnox power stations.

4. During its verification activities the team noted that the sampling trolleys located at the Reactor Coolant Gas Circuits are suffering from minor but recurrent operational failures. These failures do however not appear to significantly affect the effluent sampling programme. Faced with this shortcoming of the reliability of the equipment, the operator took the decision to replace the existing sampling trolleys with modern equipment. Replacement is planned to take place during the year 2001. The verification team fully endorses such a replacement.

The verification team considers that the control of airborne radioactivity in the Reactor Coolant Gas Circuit is broadly satisfactory. However, the verification team recommends the Environment Agency to ensure that the ongoing lack of confidence in the continuous availability of the RCG sampling devices does not negatively affect the statutory sampling programme for gaseous discharges and associated analytical results.

Dungeness A – effluents laboratory

5. The verification team considers the sample measurement devices present in the analytical laboratory to be adequate. Quality control on the equipment is assured through the implementation of written operation and calibration procedures. Sample and measurement results are well documented and traceability of results of (historical) samples is properly ensured; data management is consistent and adequate archiving of results is in place. The verification activities performed do not give rise to a specific recommendation.

6. Due to document control procedures prohibiting hard copies of working instruction to circulate, the latest approved versions of the working instructions covering sample management, assessment and reporting are made available at the analytical laboratory as electronic files on a local area network.

The pathway leading to these instructions is, however, not user-friendly. The principle of having working instructions at arms-length is not satisfactorily implemented.

The verification team recommends the operator, in the framework of general quality control, to optimise the accessibility of electronically archived working instructions.

7. The verification team noted, when auditing source documents at the analytical laboratory, that post-discharge proportional sample results had been substituted with pre-discharge results for a series of discharges that occurred in May 2000. Contrary to the ruling of the Certificate of Authorisation and the Implementation Document, the pre-discharge sample results were officially declared to the regulator and represent a departure from quality assurance and control standards.

The verification team recommends the Environment Agency to ensure that operators duly report and justify any departure from the rulings and principles laid down in the Certificate of Authorisation and detailed in the Implementation Documents.

The verification team recommends the Environment Agency to audit the operator's Management Procedures and Health Physics Instructions at set intervals in order to check the compliance of these quality control and assurance documents with the Certificate of Authorisation and related Implementation Documents.

Dungeness B – liquid discharges

8. The verification team considers that discharges of liquid radioactivity are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems. The verification activities performed do not give rise to a specific recommendation.

Dungeness B – gaseous discharges

9. The verification team considers that, at the outlets that were subject to verification activities, discharges of airborne radioactivity are properly controlled, as specified in the Certificate of Authorisation and the related Implementation Document. Quality control is implemented through compilation of comprehensive written operational procedures and interlock systems. The verification activities performed do not give rise to a specific recommendation.

10. The verification team noted that the Environment Agency does not systematically perform independent sampling of radioactive discharges. Independent, comprehensive programmes of systematic verification of radioactive effluents are in place in most Member States of the Union.

The verification team recommends the Environment Agency to consider the implementation of independent sampling of radioactive effluents to enhance the current programme of independent analysis of radioactive effluents.

Dungeness B – effluents laboratory

11. The verification team considers the sample measurement devices present in the analytical laboratory to be adequate. Quality control on the equipment is assured through the implementation of written operation and calibration procedures. Sample and measurement results are well documented and traceability of results of (historical) samples is properly ensured; data management is consistent and adequate archiving of results is in place. The verification activities performed do not give rise to a specific recommendation.

12. The verification team noted that quarterly bulk samples are split between operator and regulator. The regulator has the bulk sample analysed by its contracting laboratory in order to obtain independent confirmation of the operator's declared result. As both laboratories use identical analytical methods to measure the sample, results could be used to assess the operator's laboratory performance. The regulator omits, however, to inform the operator of the results of the independent analysis. The opportunity to provide the operator with valuable feedback is lost by this omission.

The verification team recommends the Environment Agency to consider transmitting the results of their independent effluent sampling programme to the operator concerned, more in particular with respect to bulk samples, quarterly or otherwise, so as to provide the operator with a valuable means of performing analytical quality assurance checks.

Operator's environmental monitoring and analytical laboratory

13. The verification team considers that the operator's environmental monitoring programme, the District Survey Programme, is globally satisfactory. However, the team noted that besides quarterly sampling at the four 'outer' locations (farms), only one out of eight 'inner' locations (in the immediate periphery of site) is sampled in any given quarter. Every 'inner' location is therefore sampled once every two years. It is the verification team's opinion that the sampling frequency for 'inner' locations is too low to guarantee optimal representativeness of obtained environmental data.

The verification team recommends the Environmental Agency to ensure an improvement of the representativeness of the operator's herbage sampling through the implementation of yearly herbage sampling at all 'inner' locations, on well-defined sampling spots.

14. The verification team considers that the organisation and operation of the station's environmental monitoring laboratory as well as the analytical equipment present to be excellent. High levels of quality assurance and control are in place. Environmental samples and measurement results are well documented and traceability of results of (historical) samples ensured. The verification activities performed do not give rise to any recommendation.

15. The verification team noted that environmental samples for which individual assessment of specific nuclides is required are send to the Central Radiochemistry Laboratory at Berkeley. The CRL has NAMAS/UKAS accreditation and is entitled to perform the radiochemical operations necessary for such assessments. A representative of the CRL gave a comprehensive presentation on the accredited analytical methods used for the assessment of S-35 and C-14 in herbage samples and results obtained. Taking into account the restricted scope of the verification activities it could perform the team has no further comments to make.

Environment Agency environmental monitoring programme

16. The verification team considers that the Environmental Agency environmental monitoring programme is globally satisfactory. However, the team noted a shortcoming in the quantitative assessment of aerosol-borne total beta activity and gammaspectrometric assessment of aerosol-borne radionuclides at ground level. The dry-cloth monitoring programme currently operated by FSA allows for a qualitative assessment of airborne activity concentration only.

The verification team recommends the Environment Agency to install medium velocity air samplers as collectors for representative sampling and quantitative assessment of aerosol-borne radionuclides resulting from atmospheric releases of activity. Such air samplers should be located at sites in the vicinity of the power stations where the dispersion of the releases may contribute to the dose to the population through inhalation.

Food Standards Agency environmental monitoring programme

17. The verification team considers that the Food Standard Agency environmental monitoring programme is globally satisfactory. However, the team noted that herbage as feeding stuff is not sampled. There are numerous grazing grounds for sheep in the vicinity of the Dungeness power stations.

The verification team recommends the Food Standards Agency to implement a sampling programme for herbage where herbage is intended as feeding stuff.

18. The verification team noted the high standards by which the Veterinary Laboratory Agency operates as well as the excellence of its quality management system. The verification activities performed do not give rise to any specific recommendation.

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APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY

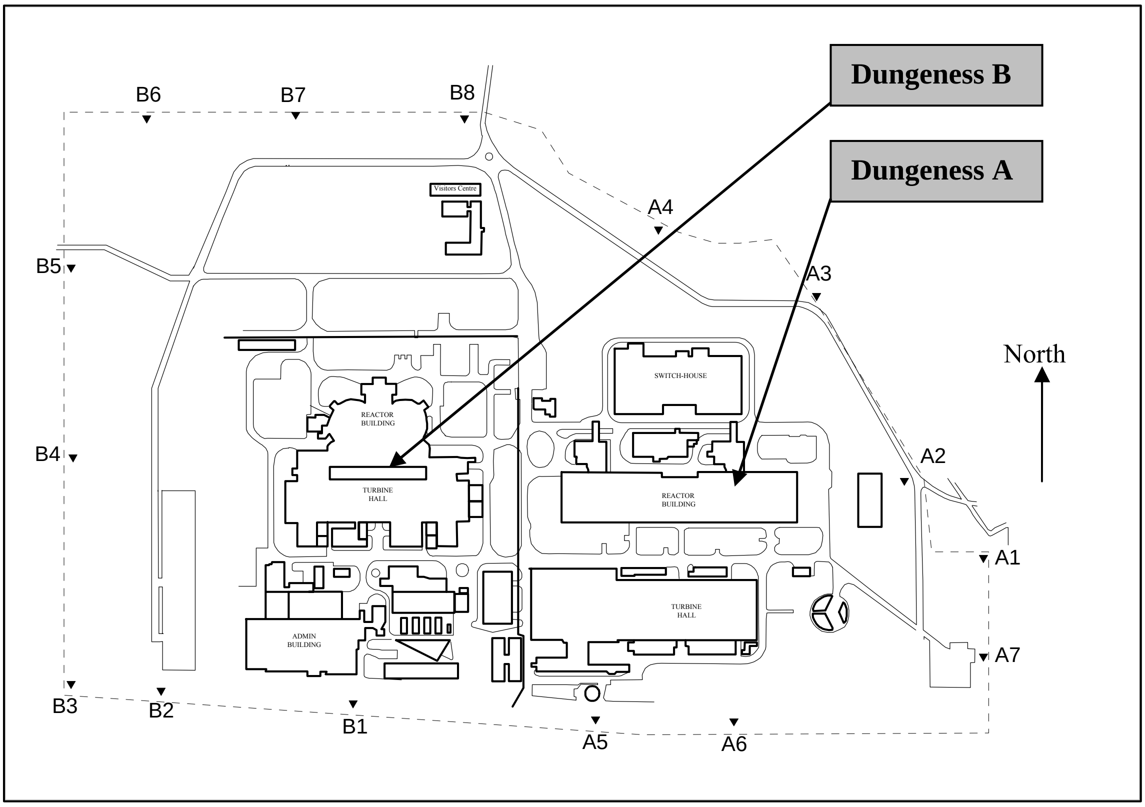
Mon 6 November	afternoon:	Welcome to the Dungeness site. Presentations and discussions on: - Magnox and Advanced Gas Reactor (AGR) power stations. - Discharge arrangements at Dungeness A and B power stations. - The operator's radiological environmental monitoring programme. - The Environment Agency (EA) monitoring programme. - The FSA monitoring programme.	
Tue 7 November:		Team-1: Team-2:	- Dungeness A liquid discharge arrangements. - Site effluent laboratory (liquid). - Dungeness B gaseous discharge arrangements. - Site effluent laboratory (gaseous).
Wed 8 November:		Team-1: Team-2:	- Dungeness A+B environmental laboratory. - Veterinary Laboratory Agency environmental laboratory, Weybridge (contractor to the Food Standards Agency).
Thu 9 November:		Team-1: Team-2:	- Dungeness A gaseous discharge arrangements. - Dungeness B liquid discharge arrangements. - Site effluent laboratory (liquid + gaseous). - Off-site environmental sampling and monitoring locations.
Fri 10 November	morning:	Wrap-up meeting.	

Note: 'Team' means 2 EC representatives accompanied by company staff members and/or competent authority.

APPENDIX 3

DUNGENESS A & B – SITE PLAN and TECHNICAL CHARACTERISTICS

1. Site plan

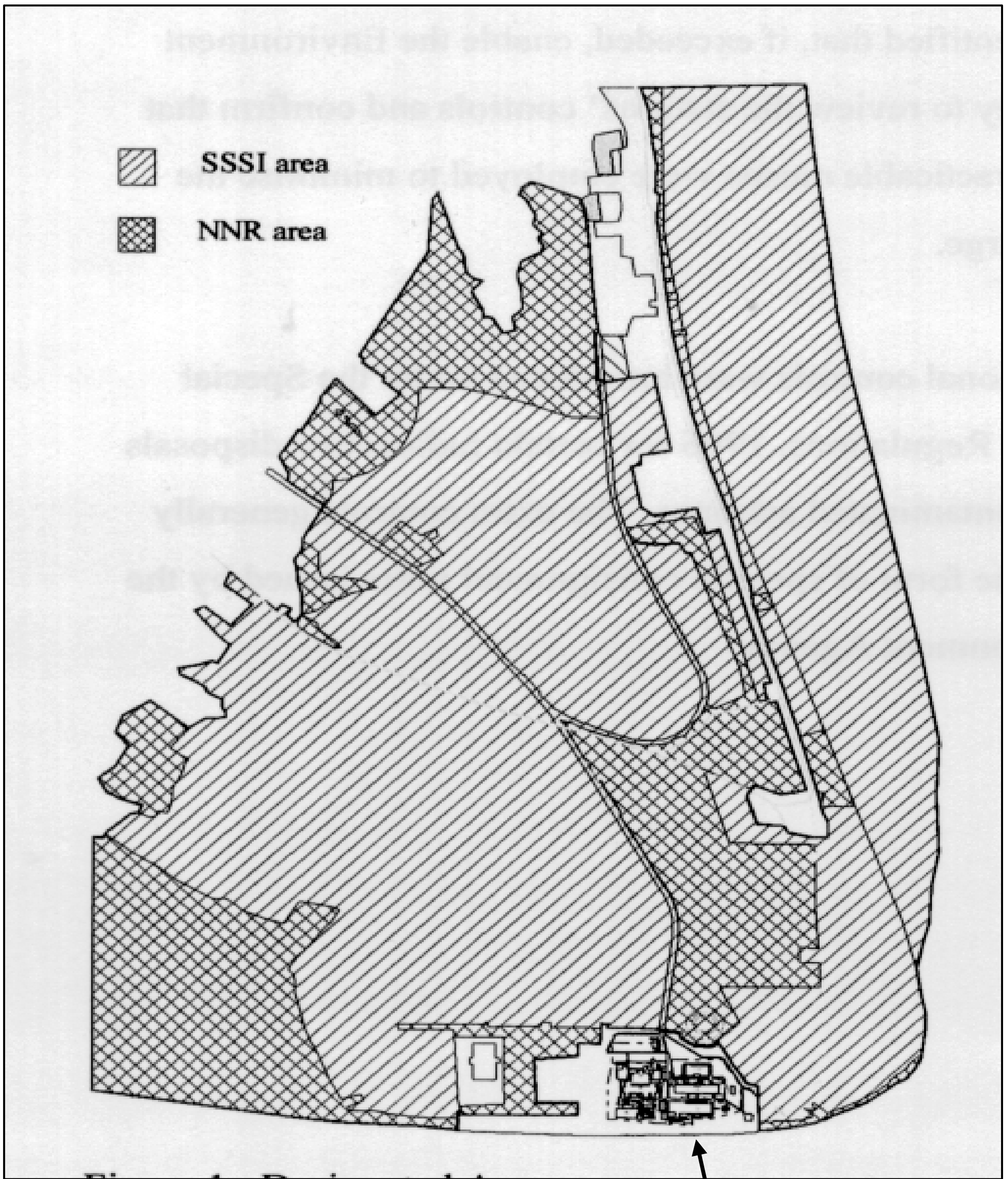


2. Technical characteristics

Item	Dungeness A	Dungeness B
Type	Magnox	AGR
Connection to grid	1965 (both units)	1983 (unit 1) – 1985 (unit 2)
Thermal power	2x 775 MW(th)	2x 1500 MW(th)
Thermal efficiency	29 %	44 %
Net electrical power	2x 225 MW (e)	2x 660 MW (e)
Nominal power output	440 MW	2x 1110 MW
Pressure vessel	Steel	Concrete
Fuel element type	Herringbone	36 pin cluster in graphite sleeve
Number of fuel elements	2x 27524	2x 2856
Fuel	Natural uranium metal	Uranium oxide Enrichment 1.457 to 2.012 %
Fuel cladding	Magnesium alloy	Stainless steel
Fuel weight (uranium)	2x 305 t	2x 135 t
Moderator	Graphite	Graphite
Coolant	Carbon dioxide	Carbon dioxide
Fuel burn-up	5500 MWd/t	18000 MWd/t
Maximum fuel rating	4.37 MW/t	20 MW/t
Boiler inlet/outlet temperatures	371/225 °C	638/280 °C
Steam temperature and pressure	363 °C/22.4 bar	560/175 C°/Kg/cm²

APPENDIX 4

DUNGENESS A & B – THE LOCAL ENVIRONMENT



Dungeness site

Note: SSSI (Site of Special Scientific Interest)
NNR (National Nature Reserve)

APPENDIX 5

DUNGENESS A & B - CURRENT DISCHARGE LIMITS

1. Dungeness A

1.1 Aqueous

Conditions and limitations:

- Waste shall be discharged into the English Channel via the Cooling Water Discharge System.
- The best practicable means shall be employed to keep the radioactivity discharged as low as is reasonably achievable.
- The quantity of aqueous waste discharged shall not exceed the values shown below:

Isotope	Annual limit	Quarterly notification level
- Tritium	35 TBq	4 TBq
- Caesium-137	1200 GBq	250 GBq
- Other radionuclides [8]	1400 GBq	300 GBq

The annual limit is calculated on a rolling month basis.
The quarterly notification level [9] is calculated per calendar quarter.

1.2 Gaseous

Limitations and conditions:

- Waste shall only be discharged through approved outlets.
- The best practicable means shall be employed to limit the activity of relevant waste disposed.
- The quantity of gaseous waste discharged shall not exceed the values shown below:

Isotope	Weekly limit	Annual limit	Quarterly notification level
- Tritium	---	3 TBq	600 GBq
- Carbon-14	500 GBq	5 TBq	1000 GBq
- Sulphur-35	150 GBq	400 GBq	70 GBq
- Argon-41	---	2000 TBq	600 TBq
- Beta particulate	---	1 GBq	375 MBq

The annual limit is calculated on a rolling month basis.
The quarterly notification level is calculated per calendar quarter.

8 Other radionuclides means: all alpha emitting radionuclides + all beta emitting radionuclides except H-3 and Cs-137.

9 If a QNL is exceeded (it is not breached because it is not a limit), then discharges must be justified.

2. Dungeness B

2.1 Aqueous

Conditions and limitations:

- Waste shall be discharged into the English Channel via the Cooling Water Discharge System.
- The best practicable means shall be employed to keep the radioactivity discharged as low as is reasonably achievable.
- The quantity of aqueous waste discharged shall not exceed the values shown below:

Isotope	Annual limit	Quarterly notification level
- Tritium	650 TBq	300 TBq
- Sulphur	2 TBq	500 TBq
- Cobalt-60	30 GBq	6 GBq
- Other radionuclides [(10)]	250 GBq	50 GBq

The annual limit is calculated on a rolling month basis.
The quarterly notification level is calculated per calendar quarter.

2.2 Gaseous

Limitations and conditions:

- Waste shall only be discharged through approved outlets.
- The best practicable means shall be employed to limit the activity of relevant waste disposed.
- The quantity of gaseous waste discharged shall not exceed the values (in GBq) shown below:

Isotope	Weekly limit	Annual limit	Quarterly notification level
- Tritium	---	15 TBq	4 TBq
- Carbon-14	400 GBq	5 TBq	900 GBq
- Sulphur-35	150 GBq	450 GBq	110 GBq
- Argon-41	---	150 TBq	25 TBq
- Iodine-131	---	5 GBq	500 MBq
- Beta particulate	---	1 GBq	250 MBq

The annual limit is calculated on a rolling month basis.
The quarterly notification level is calculated per calendar quarter.

10 Other radionuclides means: all alpha emitting radionuclides + all beta emitting radionuclides except H-3, S-35 and Co-60.

APPENDIX 6

DUNGENESS A & B – APPROVED OUTLETS FOR GASEOUS DISCHARGES

1. Dungeness A

1.1 Outlets specified in the authorisation

OUTLET		PURPOSE	FILTRATION
1.	Reactor 1 (R1) Main Blowdown and Evacuation (BE) System	Blowdown from reactor and boiler circuits, gas dryer, main bypass cyclone, standpipe head boxes and charge / discharge machine. Discharge at 50 m.	HEPA, stainless steel, candle, mesh and iodine filters.
2.	Reactor 2 (R2) Main BE System	Blowdown from reactor and boiler circuits, gas dryer, main bypass cyclone, standpipe head boxes and charge / discharge machine. Discharge at 50 m.	HEPA, stainless steel, candle, mesh and iodine filters.
3.	R1 Auxiliary BE System	Evacuation of charge /discharge machine, standpipe head boxes, upper central and lower maintenance rooms, BCD equipment, fuel transfer control room and iodine adsorption plant. Discharge at 50 m.	HEPA.
4.	R2 Auxiliary BE System	Evacuation of charge/discharge machine, standpipe head boxes, upper central and lower maintenance rooms, BCD equipment, fuel transfer control room and iodine adsorption plant. Discharge at 50 m.	HEPA.
5.	R1 Shield Cooling Air (SCA)	Removal of heat conducted from the reactor vessel. Discharge at 50 m.	Automatic roll filters.
6.	R2 SCA	Removal of heat conducted from the reactor vessel. Discharge at 50 m.	Automatic roll filters.
7.	R1 Safety Relief Valves (SRVs)	Venting of pressure vessel in the event of an over-pressurisation incident. Discharge at 50 m.	Candle filters.
8.	R2 SRVs	Venting of pressure vessel in the event of an over-pressurisation incident. Discharge at 50 m.	Candle filters.
9.	R1 Control Face Contamination Ventilation (CV)	Ventilation of rooms in the reactor building to remove airborne activity. Discharge at 21 m.	HEPA.
10.	R2 Control Face CV	Ventilation of rooms in the reactor building to remove airborne activity. Discharge at 21 m.	HEPA.
11.	R1 Fuel Face CV	Ventilation of rooms in the reactor building to remove airborne activity that may arise. Discharge at 20 m.	HEPA and iodine filters.
12.	R2 Fuel Face CV	Ventilation of rooms in the reactor building to remove airborne activity that may arise. Discharge at 20 m.	HEPA and iodine filters.
13.	Magnox Dissolution Plant (MDP)	Ventilation of MDP. Discharge at 15 m.	HEPA.

cont'd

14.	Dungeness A Medium Active Laboratory (DAMAL)	Contamination ventilation system. Discharge at 12 m.	HEPA and iodine filters.
15.	Pond Water Filtration Plant (PWFP) and Caesium Removal Plant (CRP)	Contamination ventilation system for the building, the vessels and vaults within the CRP. Discharge at 15 m.	HEPA.
16.	Active Laundry & Decontamination Centre	Contamination ventilation for various rooms and plant areas within the laundry. Discharge at 9 m.	HEPA.
17.	Tumble Dryers	Ventilation of tumble dryers. Discharge at 3 m.	Lint filter then HEPA.
18.	Chemistry Pond Laboratory	Ventilation of areas where pond chemical analysis is undertaken. Discharge at 9 m.	Pre-filter then HEPA.
19.	R1 Lower BE Rooms	Ventilation of rooms to remove contaminated air and CO_2. Discharge at 6 m.	HEPA.
20.	R2 Lower BE Rooms	Ventilation of rooms to remove contaminated air and CO_2. Discharge at 6 m.	HEPA.
21.	R1 Active Workshop	Workshop ventilation. Discharge at 3 m.	HEPA.
22.	R2 Active Workshop	Workshop ventilation. Discharge at 3 m.	HEPA.
23.	Active Waste Transit Store/ Handling Area	Area/store ventilation. Discharge at 4.5 m.	HEPA.
24.	Ponds Lugs Vaults	Ventilation of areas where lugs from spent fuel elements are stored. Discharges at 13 m.	HEPA.
25.	Reactor Standpipe Workshop	Ventilation of the area. Discharges at 23 m.	HEPA.
26.	AETP Scrubber Tower	Removal of dissolved CO_2 from treated pond-water. Discharge at 12 m.	None.
27.	Pile Cap Trench Ventilation	To remove cold CO_2 should a discharge of 'service gas' occur from the lower areas of the pile cap. Discharges at 30 m.	None.
28.	Low Level Waste (LLW) Facility CV	Contamination ventilation of rooms within the LLW facility, including storage areas and waste sorting cabinets. Discharge at 11.5 m.	HEPA.
29.	Boiler Cell Roof	Ventilation of Foundation Block and Boiler Cell. Discharges at 35 m.	None.
30.	Minor leak routes	Minor leakage from the primary circuit and potentially active leaks from the secondary circuit, *e.g.* leakage from pipework in blower halls, upper BE room or gas conditioning plant. Variable discharge height.	None.

Note: Gaseous discharges arising from the incineration of combustible waste are subject to a separate authorisation, the incinerator and oil burners are excluded from the above schedule.

1.2 Sampling schedule and radionuclide analysis

			ANALYSIS				
OUTLET		FREQUENCY	Gross Beta Particulate	S-35	H-3	C-14	Ar-41
1.	R1 Main BE System	Daily	Y(a)	Y(b)	Y(b)	Y(b)	N
2.	R2 Main BE System	Daily	Y(a)	Y(b)	Y(b)	Y(b)	N
3.	R1 Aux. BE System	Daily	Y(a)	Y(b)	Y(b)	Y(b)	N
4.	R2 Aux. BE System	Daily	Y(a)	Y(b)	Y(b)	Y(b)	N
5.	R1 SCA	Daily	Y(a)	Y(b)	Y(b)	Y(b)	Y(c)
6.	R2 SCA	Daily	Y(a)	Y(b)	Y(b)	Y(b)	Y(c)
7.	R1 SRVs	Not sampled	N	Y(d)	Y(d)	Y(d)	N
8.	R2 SRVs	Not sampled	N	Y(d)	Y(d)	Y(d)	N
9.	R1 Control Face CV	Daily	Y(a)	N	N	N	N
10.	R2 Control Face CV	Daily	Y(a)	N	N	N	N
11.	R1 Fuel Face CV	Daily	Y(a)	N	N	N	N
12.	R2 Fuel Face CV	Daily	Y (a)	N	N	N	N
13.	MDP	Weekly	Y(e)	N	N	N	N
14.	DAMAL	Weekly	Y(e)	N	N	N	N
15.	PWFP and CRP	Monthly	Y(f)	N	N	N	N
16.	Active Laundry	Monthly	Y(g)	N	N	N	N
17.	Tumble Dryers	Not sampled	N	N	N	N	N
18.	Chemistry Pond Lab.	Not sampled	N	N	N	N	N
19.	R1 Lower BE Rooms	Monthly	Y(g)	N	N	N	N
20.	R2 Lower BE Rooms	Monthly	Y(g)	N	N	N	N
21.	R1 Active Workshop	Monthly	Y(g)	N	N	N	N
22.	R2 Active Workshop	Monthly	Y(g)	N	N	N	N
23.	Active Waste Transit Store/Handling Area	Monthly	Y(g)	N	N	N	N
24.	Ponds Lugs Vaults	Monthly	Y(g)	N	N	N	N
25.	Reactor Standpipe Workshop	Monthly	Y(g)	N	N	N	N
26.	AETP Scrubber Tower	Not sampled	N	N	N	N	N
27.	Pile Cap Trench Vent.	Not sampled	N	N	N	N	N
28.	LLW Facility CV.	Monthly	Y(g)	N	N	N	N
29.	Boiler Cell Roof	Not sampled	N	N	N	N	N
30.	Minor leak routes	Not sampled	N	N	N	N	N

Y = sampled / analysed N = not sampled / not analysed

cont'd

Notes:

(a) Sampling is continuous, with filter papers changed every 24 hours.

(b) Tritium, C-14 and S-35 will be estimated from daily assessment of reactor gas. On Public Holidays, a screening measurement will be carried out on the in-circuit bubbler samples to check for any unusual release, followed by the formal measurement of their specific activity on the next normal working day.
Stack sampling facilities will be maintained as a back-up to in-circuit sampling facilities, should these be rendered inoperable or inappropriate.

(c) Ar-41 discharges are assessed monthly by calculation from a knowledge of reactor power and shield cooling air flows.

(d) Discharges via Safety Relief Valves take place very infrequently and cannot be measured directly. When necessary an estimate shall be made, based on measurements on the bulk reactor gas.

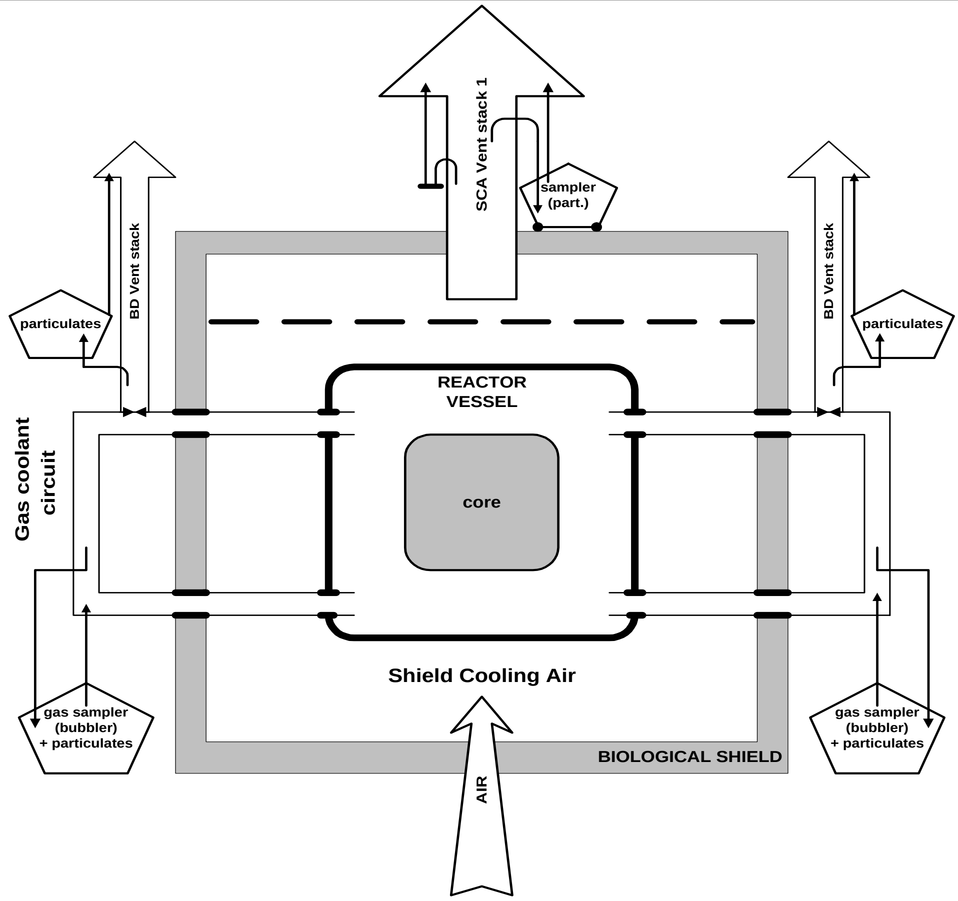
(e) Sampling is continuous, with filter papers changed every 7 days.

(f) A 24-hour sample is taken once per month.

(g) A 24-hour sample is taken once per month.

(h) The capability for alpha activity assessment of discharges will be maintained by periodic measurement.

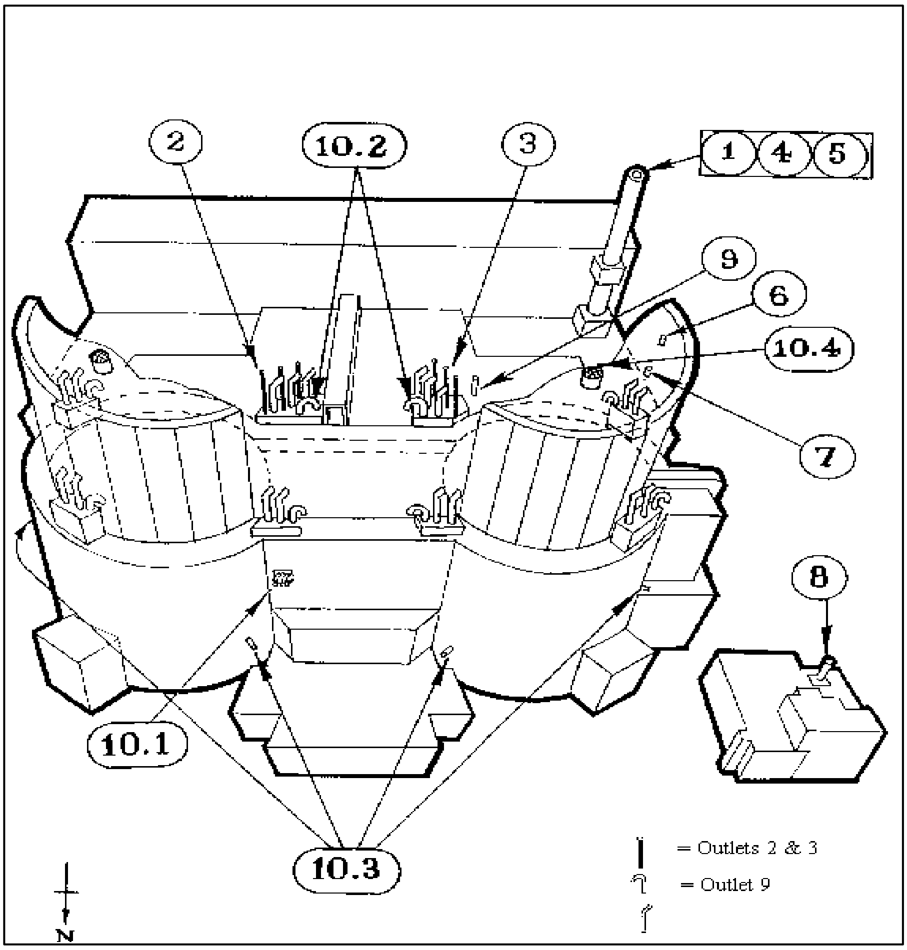
1.3 Sampling schematic



Notes:
- Only 2 out of 4 RCG circuit loops are drawn in this schematic.
- Only 1 out of 3 SCA vent stacks are drawn in this schematic.
- Each RCG loop has a BD vent associated with it.

2. Dungeness B

2.1 The drawing shows the location of the approved outlets, the full number of each outlet is not necessarily shown.



2.2 Outlets specified in the authorisation (see also schematic under section 2.4)

OUTLET	PURPOSE	FILTRATION
1. Blowdown System.	Blowdown and venting of reactor gas from units R21 and R22. Blowdown of gas from the fuelling machine. Discharge at 82m level.	Sintered metal pre-filters, charcoal bed and sintered metal post-bed filters.
2. Reactor 21 Safety Relief Valves.	Relief of excess pressure in the reactor gas circuits during fault conditions. Discharge at 44.2m level.	Pleated sintered stainless steel fibre filters.
3. Reactor 22 Safety Relief Valves.	Relief of excess pressure in the reactor gas circuits during fault conditions. Discharge at 44.2m level.	Pleated sintered stainless steel fibre filters.
4. Active Areas HV1A. (a)	Ventilation of potentially contaminated areas within Reactor Controlled Area. Discharge at 82m level.	Pre and HEPA filters.

cont'd

5. Monitored Areas HV1C. (b)	Ventilation of areas within Reactor Controlled Area which are not normally contaminated, including Source Store. Discharge at 82m level.	None.
6. Autoclaves HV10.	Ventilation of the Autoclave Building. Discharge at 72.4m.	Pre and HEPA filters.
7. Reactor Man Access HV13.	Purging of shutdown reactor internals. Discharge at 53m level.	Pre, HEPA and charcoal filters.
8. Active Laundry HV25.	Ventilation of the Active Laundry Building. Discharge at 6m level.	Pre and HEPA filters.
9. Irradiated Fuel Disposal (IFD) facility stack.	Purge and/or venting of the IFD cell. Discharge at 44.2m level.	Pre, HEPA and charcoal filters.
10 Other places approved in writing by the authorising body. See table B below.		

Notes (a) The HV1A Stack at the 82m level is also the discharge route for:

1. Discharges from auxiliary reactor plant items via the Auxiliaries Blowdown Route. Buffer Store blowdowns via this route are filtered by sintered metal filters. All other discharges are unfiltered.
2. Discharges from In-Core Inspection Equipment via bursting discs. Discharges are filtered by the HV1A filters.

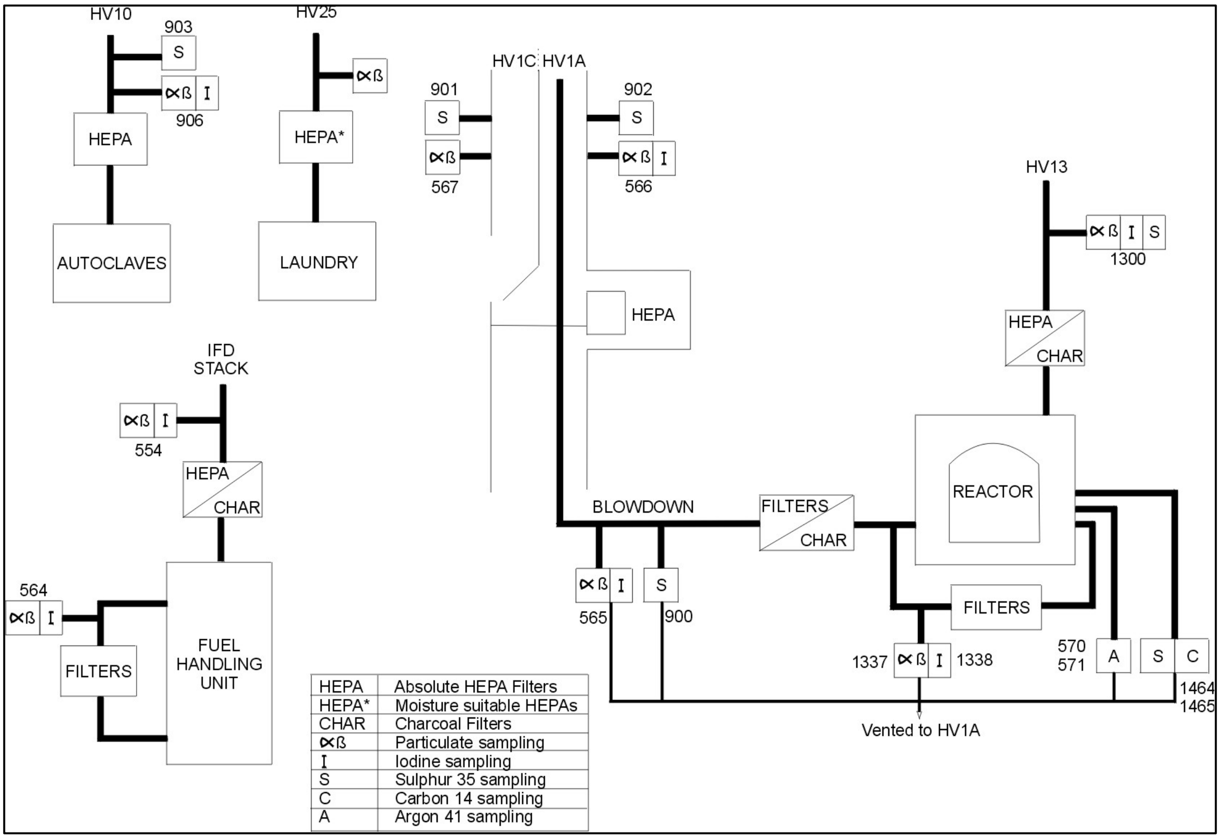
(b) The HV1A Stack at the 82m level is also the discharge route for discharges from the Gas Circulator Seal Oil Vents which degas the oil used to maintain gas circulator running seals. Discharges are unfiltered.

2.3 Other approved outlets (see also schematic under section 2.4)

OUTLET	PURPOSE	FILTRATION
10.1 Buffer Stores 21 & 23 Safety Relief Valves.	Relief of excess pressure in the Buffer Stores. Discharge at 30m level.	Sintered metal filter.
10.2 Gas Circulator Main Oil Tank Ventilation.	Maintains main oil tank at atmospheric pressure during routine/normal operation. Discharge at 36m level.	None
10.3 Gas Circulator Main Oil Tank Relief Pipework.	Relief of excess CO_2 pressure in the main oil tank during fault conditions. Discharge at 13m level.	None
10.4 Charge Hall, HV1B (a)	Ventilates Charge Hall above approx 2m. Discharge at 70m level.	None
10.5 Miscellaneous points of minor discharge.	Various, discharging in total, less than 1% of authorisation limits.	None

Notes (a) The Charge Hall, HV1B, System is also the discharge route for discharges from the Fuelling Machine Safety Relief Valve. Discharges via this route are filtered via sintered bronze filters before discharge into the Charge Hall.

2.4 Schematic

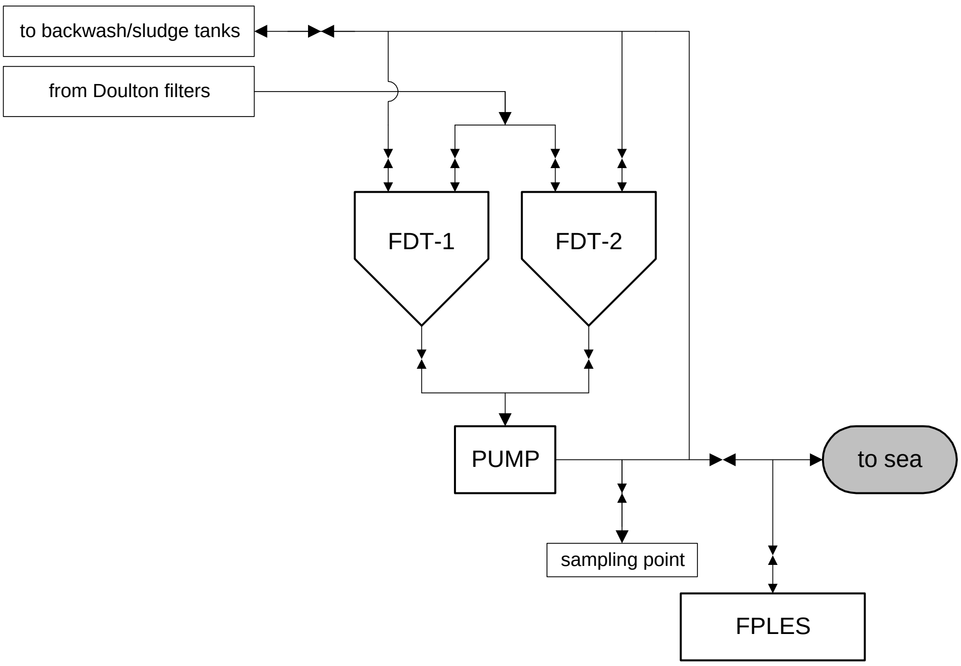


APPENDIX 7

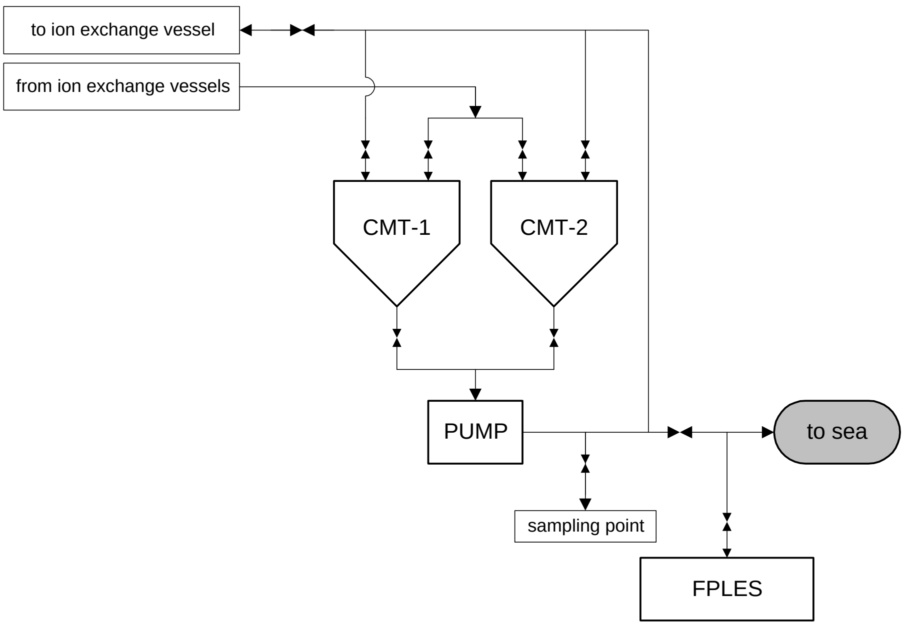
DUNGENESS A & B – LIQUID DISCHARGE SYSTEMS

1. Dungeness A

1.1 FDT - final (monitoring) delay tanks - discharge system

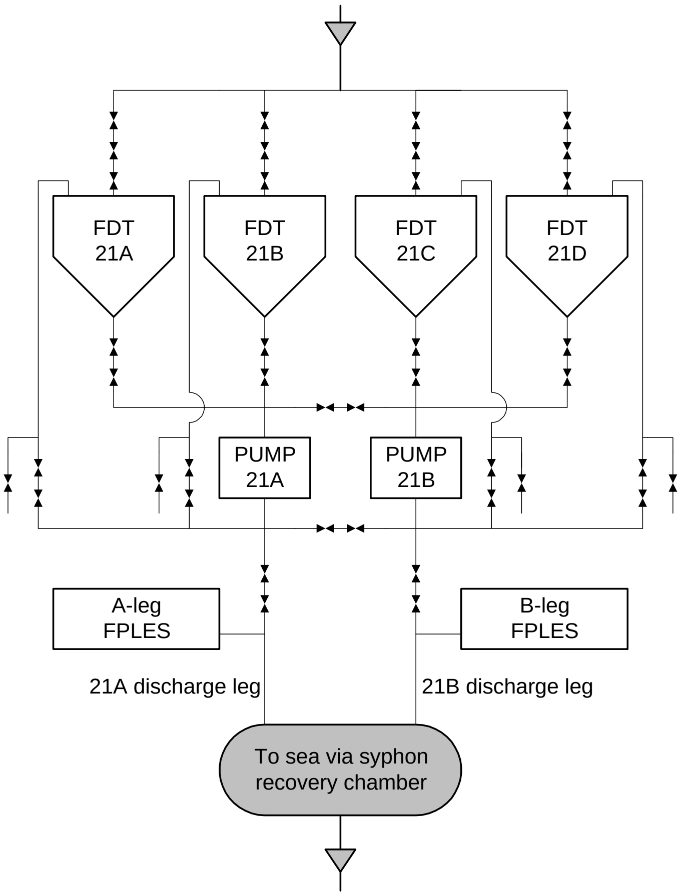


1.2 CMT - collection monitoring tanks - discharge system (Magnox dissolution plant)

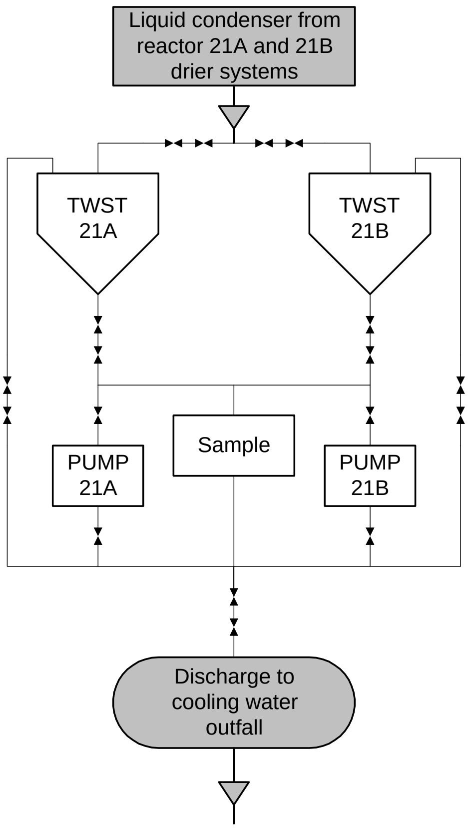


2. Dungeness B

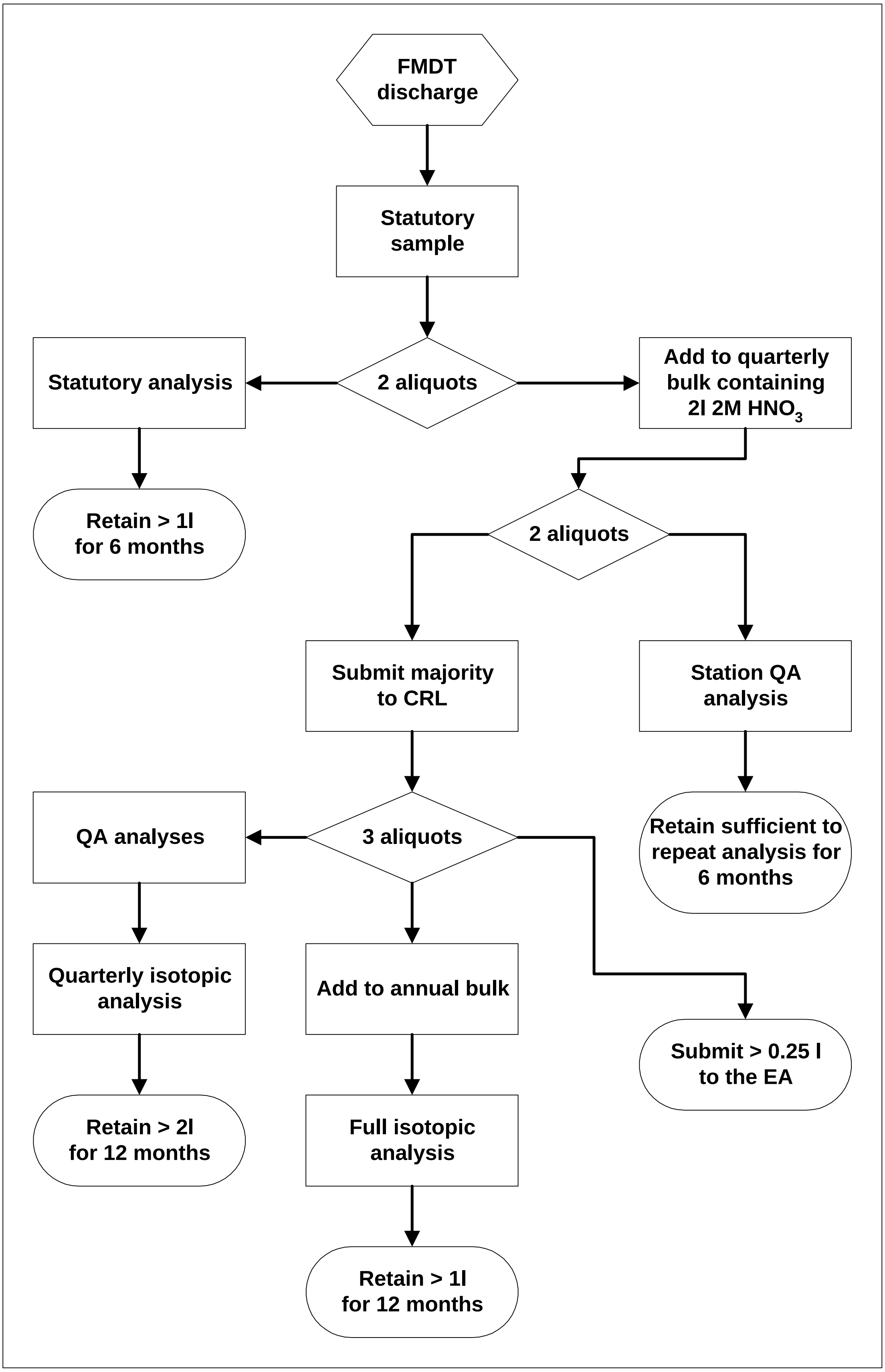
2.1 FDT - final (monitoring) delay tanks - discharge system



2.2 TWST - tritiated water storage tanks - discharge system



2.3 Analysis and QA flow-chart



APPENDIX 8

DUNGENESS A & B – RECORDING OF DISCHARGE RESULTS

1. Dungeness A

1.1 Analytical measurements are recorded as:

$x \pm 2\sigma$

Where x is the calculated discharge activity and σ is the standard deviation of that activity based on counting statistics alone. Therefore, no confidence level should be assigned to the recorded error. The combination of software and hardware for gamma spectrometry may only give "< MDA", in which case that is all that can be recorded, although the value of σ is usually given by the analytical software. Monthly totals should be calculated from the sum of the calculated discharge activities for that month.

Although discharges are recorded as "x ± 2σ", irrespective of the size of "x" or "σ", they should be reported as either positive values or less than a value derived from the minimum detectable activity (MDA). The derivation of the MDA depends on the radionuclide in question.

When reporting results those records should be interpreted as follows:

if $x < MDA$	then report: $< MDA$
if $MDA < x < 4\sigma$	then report: $< [x \pm 2\sigma]$
if $x > 4\sigma$	then report: x

1.2 MDA (minimum detectable activity) is calculated as follows:

For direct measurement of ^{41}Ar or ^{131}I the method for determining the MDA should be that for gamma emitting nuclides, defined according to:

$$MDA = \frac{4.65}{E} \cdot \sqrt{\frac{B}{t}}$$

where

B	background count rate
t	counting time
E	detector efficiency factor

The use of counting statistics to derive an MDA was developed for gamma spectrometry, but LSC and alpha counting equipment might not provide an assessment of the counting error or an MDA. Where the statistical counting error is not provided by analytical software, it can be calculated from:

$$\sigma = \sqrt{\frac{R_T}{T_T} + \frac{R_B}{T_B}}$$

Where: σ is the standard deviation of the sample count rate,
R_T is the gross count rate for the sample,
R_B is the gross background count rate,
T_T is the sample count time and
T_B is the background count time.

1.3 Reporting of monthly total discharges (also see appendix 9.1)

The first page lists monthly discharges from individual outlets, using 3 rows per outlet (Max/d, Min/d and Total/m) and a column per scheduled nuclide.

All discharges are reported in MBq.

The scheduled nuclides appear in the order: beta particulate, Tritium, S-35, C-14 and Ar-41; followed by an additional column specifying the discharge of CO_2.

The second page gives the monthly summary for the site; including for each scheduled nuclide:

- Total monthly discharge, the rolling annual total discharge (both in MBq and as a percentage of the limit).
- The quarterly total discharge (both in MBq and as a percentage of the QNL).
- The maximum week's discharge during the month - if appropriate (both in MBq and as a percentage of the limit).

The second page also includes information on:

- The state of the reactors during the month (*i.e.* load factor).
- Any departure from the declared sampling frequency for any outlet.
- Any other relevant comment.

2. Dungeness B

2.1 Measurement errors are categorised as follows:

- Sampling errors
- Sample preparation errors
- Standard source uncertainty
- Sample volume / sample fraction errors
- Counting errors

Error types a, b and c are kept to a minimum by the application of good techniques and are taken to be small compared with the uncertainties in counting statistics. Errors of type d may be significant but are not acknowledged in the calculations. Normally pessimistic values are employed. However, sampling probe defects, ventilation extract fan outages, additional ventilation air extraction and sampling flow rate changes will affect the sampling fractions and must be considered in calculating releases.

2.2 Analytical measurements are recorded as:

'<MDA'	if $x < MDA$
'<[x + 2σ]'	if $MDA < x < 4\sigma$
'x ± 2σ'	if $x > 4\sigma$

Where x is the calculated discharge activity and σ is the standard deviation of that activity based on counting statistics alone. The 2σ value of σ includes no other uncertainties such as sampling errors and therefore no confidence level can be assigned to the recorded error.

Anomalous results will be identified against specified local action levels and investigated as appropriate.

2.3 MDA (minimum detectable activity) is calculated as follows:

$$MDA = \frac{4.65}{E} \cdot \sqrt{\frac{B}{t}}$$

where

B	background count rate
t	counting time
E	detector efficiency factor

The means of calculation of MDA depends on the counting system used:

- For Ar-41 and I-131 discharges, determined by gamma spectrometry, individual sample MDAs are determined by the system software. For H-3, C-14 and S-35, determined by liquid scintillation counting and for particulate discharges, system MDAs are calculated from background and efficiency results.

- For 'hard and soft activity', tritium, S-35, and isotopes of energy greater than S-35, determined by liquid scintillation counting, MDAs are calculated from background and efficiency results. For Co-60 determined by gamma spectrometry, individual sample MDAs for are determined by the system software.

2.3.1 Typical MDAs for gaseous discharge samples are:

Atmospheric - Species	MDA	Notes
A-41	10 kBq/kg	- The Ar-41 MDA is for Ar-41 activity in reactor gas.
S-35 (direct count) C-14 Tritium	150 Bq/l 150 Bq/l 170 Bq/l	- S-35, C-14 and H-3 MDAs are for activity in sample bubbler liquors. MDAs for activity discharged will vary with the sample fraction for each system.
I-131 (daily count) (weekly analysis) Beta particulate	20 Bq 0.8 Bq 0.315 Bq	- I-131 and particulate MDAs are for activity on sample packs and filter papers. MDAs for activity discharged will vary with the sample fraction for each system.

2.3.2 Typical MDAs for liquid discharge samples are:

Liquid - FDT – Species	MDA (Bq/l)
Tritium	200
S-35 (precipitate)	13
(direct measurement)	130
Co-60	25
Total activity excluding tritium	45
Liquid - TWST - Species	**MDA (Bq/l)**
Tritium	1.7 E+05
S-35	1.3 E-05
Co-60	25
Total activity excluding tritium	1.0 E+05

2.4 σ (statistical uncertainty) is calculated as follows:

$$\sigma = \sqrt{\frac{R_T}{T_T} + \frac{R_B}{T_B}}$$

where

- σ standard deviation
- R_T gross sample count rate
- R_B gross background count rate
- T_T sample count time
- T_B background count time

The means of calculation of σ depends on the counting system used:

- For A-41 and I-131 discharges, determined by gamma spectrometry, and H-3, C-14 and S-35, determined by liquid scintillation counting, individual sample values of σ are determined by the counting system software. For particulate discharges σ is manually calculated from the raw count data.
- For 'hard and soft activity', H-3, S-35 and isotopes of energy greater than S-35, determined by liquid scintillation counting, values of σ are determined by the counting system software. For isotopes determined by gamma spectrometry, individual uncertainties are calculated for each nuclide measured in a sample.

2.5 Reporting of monthly total discharges (also see appendix 9.2)

Monthly total discharges are reported to 3 significant figures as the simple sum of positive, '<MDA' and '<[x + 2σ]' results. 'Less-than' notation is only used in discharge totals when 'less-than' results predominate.

APPENDIX 9

DUNGENESS A & B
REPORTING OF RADIOACTIVE DISCHARGES
TO THE ENVIRONMENTAL AGENCY

1. Dungeness A

1.1 Gaseous discharges

Note that tables 1.1.1 and 1.1.2 are part of a single document signed and dated by the Station Manager or deputy before despatch to the EA.

1.1.1 Monthly summary record:

Frequency	**Outlet**	**Particulate beta**	**H-3**	**S-35**	**C-14**	**Ar-41**	**CO_2**
Max/d Min/d Total/m	R1 main BD & evacuation route.	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	0.0 0.0 0.0
Max/d Min/d Total/m	R2 main BD & evacuation route.	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	0.0 0.0 0.0
Max/d Min/d Total/m	R1 aux. BD & evacuation route.	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m
Max/d Min/d Total/m	R2 aux. BD & evacuation route.	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m
Max/d Min/d Total/m	R1 SCA.	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	[<] xxx [<] xxx [<] xxx	n/m n/m n/m
Max/d Min/d Total/m	R2 SCA.	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	[<] xxx [<] xxx [<] xxx	n/m n/m n/m
Max/d Min/d Total/m	Control face contamination vents.	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m
Max/d Min/d Total/m	Fuel face contamination vents.	[<] xxx [<] xxx [<] xxx	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m
Max/d Min/d Total/m	Minor routes.	n/m n/m [<] xxx	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m	n/m n/m n/m

Legend:
- n/m = not measured
- 0.0 = Te as unit
- xxx = MBq as unit, scientific format (0.0 E+00)

1.1.2 Cumulative monthly totals as percentage of authorised limits:

Nuclides	**Monthly total**	**Cumul'd total last 12 months**	**% of site annual limit**	**Cumul'd total in calendar quarter**	**% of site quarterly notification**	**Max. weekly total this month**	**% of site weekly limit**
Beta	xxx	xxx	x %	xxx	x %	n/m	n/m
Tritium	xxx	xxx	x %	xxx	x %	n/m	n/m
S-35	xxx	xxx	x %	xxx	x %	xxx	x %
C-14	xxx	xxx	x %	xxx	x %	xxx	x %
Ar-41	xxx	xxx	x %	xxx	x %	n/m	n/m

Legend:
- n/m = not relevant
- xxx = MBq as unit, scientific format (0.0 E+00)

1.2 Liquid discharges

Note that tables 1.2.1 and 1.2.2 are part of a single document signed and dated by the Station Manager or deputy before despatch to the EA.

a) Monthly FDT and CMT return record

Discharges			Tank number	Volume discharge	Tritium		Caesium-137		Hard activity	Other radionuclides	
Date started	Time started	Time finished		m³	MBq/m³	GBq	MBq/m³	GBq	MBq/m³	MBq/m³	GBq
Final Delay Tanks											
dd-mmm-yy	hh:mm	hh:mm	x/xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
etc.											
Collection Monitoring Tanks											
dd-mmm-yy	hh:mm	hh:mm	x/xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
etc.											
Totals				xxx		xxx		xxx			xxx

b) Totals for station

	GBq		
	H-3	Cs-137	Other RN
Total for this quarter	yyy	yyy	yyy
Quarterly notification level	zzz	zzz	zzz
Total in last consecutive 12 months	yyy	yyy	yyy
Annual limit	zzz	zzz	zzz

Remarks:

(i) Calculated discharges are quoted to 4 significant figures or 3 decimal places where appropriate.
(ii) Data concerning dates, start/finish times, batch numbers, volumes discharged and activity measurements are entered in section "a". The report is set up as a spreadsheet to automatically calculate the discharge activities for the various nuclides.
(iii) yyy = cumulative activities for the various nuclides.
zzz = authorised activity levels/limits for the various nuclides.

2. Dungeness B

2.1 Gaseous discharges

Note that tables 2.2.1, 2.2.2 and 2.2.3 are part of a single document signed and dated by the Station Manager or deputy before despatch to the EA.

2.1.1 Monthly summary record:

		Particulate							
Frequency	**Outlet**	**Alpha**	**Beta**	**H-3**	**S-35**	**I-131**	**C-14**	**Ar-41**	**CO_2**
Max/d Min/d Total/m	Blowdown system	n/r n/r n/r	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	n/a n/a zzz
Max/d Min/d Total/m	Active areas (HV1A)	n/r n/r n/r	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	n/a n/a zzz
Max/d Min/d Total/m	Monitored areas (HV1C)	n/r n/r n/r	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a
Max/d Min/d Total/m	Autoclaves (HV10)	n/r n/r n/r	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a
Max/d Min/d Total/m	Reactor man access (HV13)	n/r n/r n/r	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a
Max/d Min/d Total/m	Active laundry (HV25)	n/r n/r n/r	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a	n/a n/a n/a
Max/d Min/d Total/m	IFD stack	n/r n/r n/r	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	xxx xxx xxx	n/a n/a n/a	n/a n/a n/a	n/a n/a zzz
Monthly totals		**n/r**	**xxx**	**xxx**	**xxx**	**xxx**	**xxx**	**xxx**	**zzz**

Legend:
- n/r = not reported
- n/a = not applicable
- xxx = MBq as unit, scientific format (0.00 E+00)
- zzz = Te as unit, scientific format (0.00 E+00)

2.1.2 Cumulative monthly totals as percentage of authorised limits:

Month year	**Monthly total**	**Cumul'd total last 12 months**	**% of site annual limit**	**Cumul'd total in calendar quarter**	**% of site quarterly notification**	**Max. weekly total this month**	**% of site weekly limit**
β particulate	xxx	xxx	x %	xxx	x %	n/r	x %
tritium	xxx	xxx	x %	xxx	x %	n/r	x %
S-35	xxx	xxx	x %	xxx	x %	xxx	x %
I-131	xxx	xxx	x %	xxx	x %	n/r	x %
C-14	xxx	xxx	x %	xxx	x %	xxx	x %
Ar-41	xxx	xxx	x %	xxx	x %	n/r	x %

Legend:
- n/r = not relevant
- xxx = MBq as unit, scientific format (0.00 E+00)

2.2 Liquid discharges

Note that tables 2.2.1, 2.2.2 and 2.2.3 are part of a single document signed and dated by the Station Manager or deputy before despatch to the EA.

2.2.1 Monthly FDT summary record:

FDT discharges			**Tritium**		**Co-60**		**Total activity excluding H-3**	
Date	**No of tanks**	**Volume (m^3)**	**MBq/m^3**	**GBq**	**MBq/m^3**	**GBq**	**MBq/m^3**	**GBq**
1				< 0.000		< 0.000	<	< 0.000
2				< 0.000		< 0.000	<	< 0.000
3				< 0.000		< 0.000	<	< 0.000
4				< 0.000		< 0.000	<	< 0.000
---				< 0.000		< 0.000	<	< 0.000
---				< 0.000		< 0.000	<	< 0.000
---				< 0.000		< 0.000	<	< 0.000
---				< 0.000		< 0.000	<	< 0.000
28				< 0.000		< 0.000	<	< 0.000
29				< 0.000		< 0.000	<	< 0.000
30				< 0.000		< 0.000	<	< 0.000
31				< 0.000		< 0.000	<	< 0.000
Totals		**0.0**		**< 0.000**		**< 0.000**		**< 0.000**

	GBq
Monthly total S-35 from bulk:	0.000
Monthly total other activity:	< 0.000

Note: Other activity is total activity excluding H-3, S-35 & Co-60. The monthly total FDT discharge of other activity is determined by difference from the total activity excluding H-3, and the S-35 & Co-60 totals reported above.

2.2.2 Monthly TWST summary record:

TWST discharges			**Tritium**		**S-35**		**Co-60**		**Activity E > S-35**	
Date	**TWST**	**(m^3)**	**MBq/m^3**	**GBq**	**MBq/m^3**	**GBq**	**MBq/m^3**	**GBq**	**MBq/m^3**	**GBq**
				xxx		xxx		xxx		xxx
				xxx		xxx		xxx		xxx
				xxx		xxx		xxx		xxx
				xxx		xxx		xxx		xxx
Totals		**0.000**		**xxx**		**xxx**		**xxx**		**xxx**

Legend - xxx = GBq as unit, scientific format (0.00 E+00)

2.2.3 Station total discharges:

	Volume m³	Discharges GBq			
		H-3	**S-35**	**Co-60**	**Other**
Monthly total	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Total in calendar quarter		0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Quarterly notification level		3.00 E+05	5.00 E+02	6.00 E+00	5.00 E+01
Total in last 12 consecutive months		0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Annual limit		6.50 E+05	2.00 E+03	3.00 E+01	2.50 E+02

Notes:

1. This return is made under the Dungeness B liquid discharge authorisation effective from 1 April 1996.
2. Other activity is total activity excluding H-3, S-35 & Co-60. The station total other activity discharged is determined by summing the monthly FDT discharge of other activity and the monthly total TWST discharge of activity with energy > S-35 corrected for TWST Co-60 discharges.
3. Rounding may cause apparent errors in the 3rd significant figure in quantities derived above.

APPENDIX 10

DUNGENESS A & B – ENVIRONMENTAL MONITORING PROGRAMME

1. Gamma doserate survey

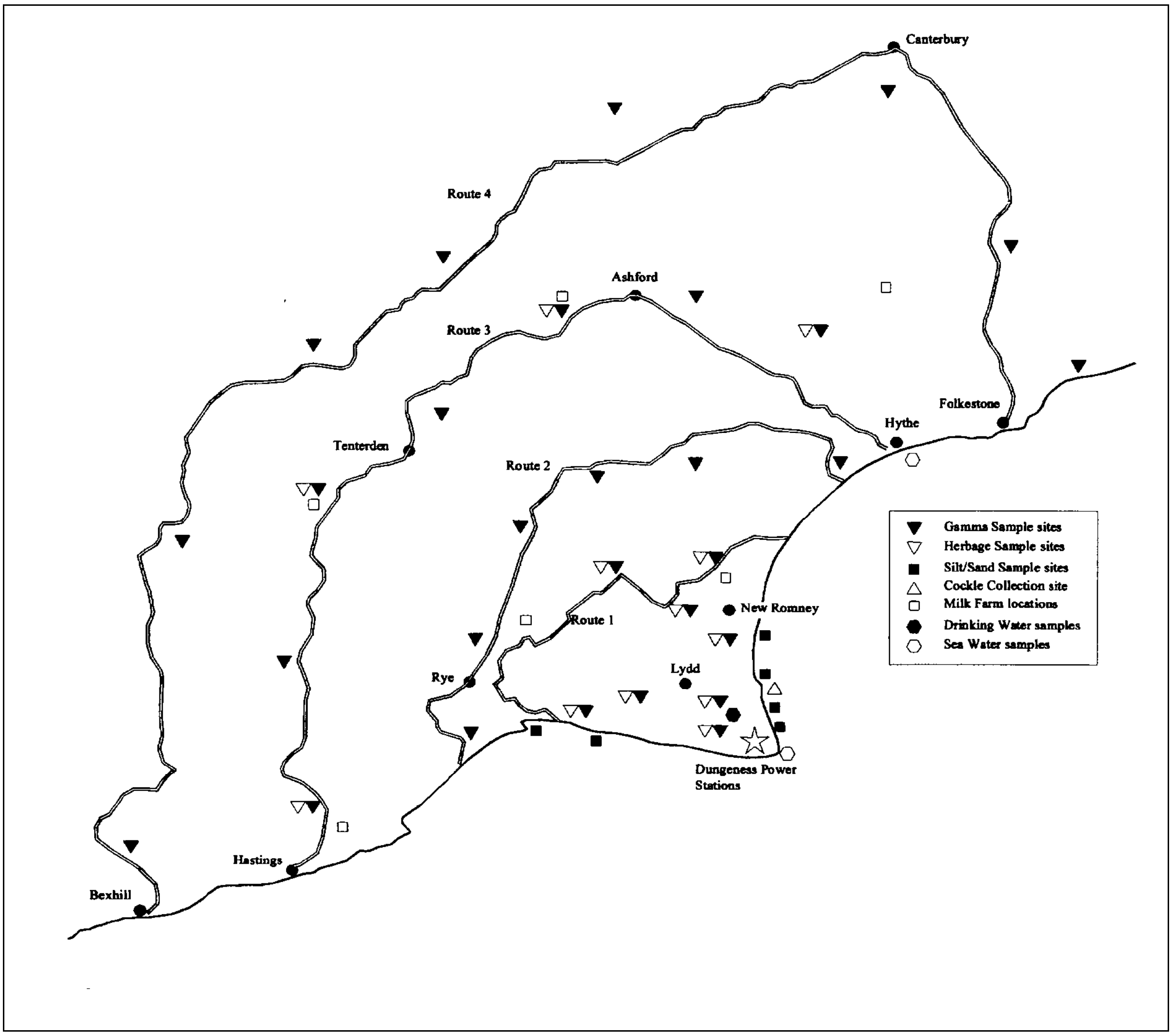
	Number of locations	Measurement
Inner gamma sites	10 locations	3x 100 seconds per location
Shore gamma sites	10 locations	3x 100 seconds per location
Ring road 1	6 locations	3x 100 seconds per location
Ring road 2	7 locations	3x 100 seconds per location
Ring road 3	8 locations	3x 100 seconds per location
Ring road 4	8 locations	3x 100 seconds per location

2. Sampling programme

Sample	No. of sites	Frequency	Analyses
Milk	2	Fortnightly	^{131}I ^{35}S ^{35}S ^{14}C on bulk samples (by CRL)
Herbage	5	Quarterly	^{35}S ^{14}C on bulk samples (by CRL)
Sediment	6	Monthly	Gross beta (using a ^{40}K standard) Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Plaice	Local	Monthly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Cod	Local	Quarterly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Shrimp	Local	Quarterly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Molluscs	Local	Quarterly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Cockles	Local	Quarterly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Whelks	Local	Quarterly	Gross beta Gamma spectrometry for ^{60}Co ^{65}Zn ^{134}Cs ^{137}Cs ^{241}Am + any other anthropogenic nuclides detected
Domestic water	4	Monthly	Gross beta

APPENDIX 11

DUNGENESS A & B – ENVIRONMENTAL MONITORING SITES



APPENDIX 12

ENVIRONMENT AGENCY
ENVIRONMENTAL MONITORING PROGRAMME
DUNGENESS AREA

Location	Sampling Frequency (y^{-1})	Analytical Requirement
Natural waters		
Standing Water at Long Pits	2 (Spring/Autumn)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{35}S, ^{134}Cs, ^{137}Cs, ^{60}Co and other gamma emitting nuclides present above detection limit.
Pumping station Well No 1 Well No 2 Well No 3	 1 (Spring) 1 (Autumn) 1 (Spring)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{35}S, ^{134}Cs, ^{137}Cs, ^{60}Co and other gamma emitting nuclides present above detection limit.
Reservoir	1 (Autumn)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{35}S, ^{134}Cs, ^{137}Cs, ^{60}Co and other gamma emitting nuclides present above detection limit.
Sediment		
Rye Harbour	2	Total beta (as ^{137}Cs), Gamma spectrometry.
Rye Harbour	2	Total beta (as ^{137}Cs), Gamma spectrometry.
Camber Sands	2	Gamma spectrometry.
Pilot Sands	2	Gamma spectrometry.
Seawater		
Local Beach	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), Gamma spectrometry.
Seaweed [11]		
Copt Point	2	Gamma spectrometry, ^{99}Tc.
Instrumental monitoring		
Rye Bay	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.
Jury Gap	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.
Dungeness South Coast	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.
Dungeness East Coast	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.
Greatstone on Sea	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.
Littlestone on Sea	2 (Spring/Autumn)	Gamma dose rate at 1m height, Beta/gamma contact contamination.

11 Principally to monitor for Sellafield discharges, particularly Tc-99.

APPENDIX 13

ENVIRONMENT AGENCY – ANALYTICAL METHODS (ENVIRONMENTAL)

1. Total alpha activity

Samples are extracted with acids (where necessary) to obtain a solution and after the addition of plutonium-236 as a yield tracer are filtered. Samples are prepared as electrodeposited sources and counted under vacuum using silicon surface barrier detectors. Total alpha values are obtained by summing all counts obtained over eight hours (less a standard subtraction for background) in the energy range 3-8 MeV after corrections for radiochemical yield and counting efficiency.

2. Total beta activity

All total beta values are measured after removal of tritium. Samples (liquid) are reduced to dryness and re-dissolved in aqueous solution. The products are counted by liquid scintillation counting using caesium-137 as a calibration standard.

3. Gamma-ray spectrometry

The determination of gamma-emitting nuclides is carried out using gamma-ray spectrometry. The equipment consists of a number of high-resolution germanium detector systems linked to a multi-tasking hard disc multi-channel analyser assembly for spectrum recording and data processing. Nuclide identification is based on gamma photon centroid energy evaluation and quantitative measurements are made using energy-related efficiency calibrations. These calibrations provide an energy and counting efficiency relationship for a given sample matrix and volume and are established using traceable multi-component gamma standards.

4. Alpha spectrometry

The determination of alpha-emitting nuclides is carried out using a combination of radiochemical separation procedures combined with alpha spectrometry. The complexity of the radiochemical separation procedure chosen is dependent on the precise analytical requirements for nuclide identification (see below). All samples are prepared for analysis in the form of electrodeposited sources and are counted under vacuum using silicon surface barrier detectors.
Counting periods are chosen to be in the range one to four days. Yield tracers are used to calculate chemical recovery and counting efficiency and are selected on the basis of low environmental occurrence. The alpha counting chambers are routed via a multi-channel buffer to a personal computer for the analysis of data by a suitable software package. Nuclide identification is based on alpha peak centroid energy and quantitative determination based on nett peak area after correction for counting efficiency and radiochemical recovery.

5. Analysis of grass samples for organically bound tritium

A suitable weight of dried grass sample is ashed slowly in a copper oxide furnace tube with a bleed of carrier gas. The effluent gases are passed through a cooled condenser and the resultant condensate is counted for tritium on a liquid scintillation counter.

6. Specific nuclide methods

6.1 Plutonium, americium, thorium, uranium, curium

Samples are ashed, extracted with boiling hydrochloric acid and filtered (rejecting the insoluble residue). To the filtrate is added oxalic acid and sodium sulphite and the pH is adjusted. The supernatant is rejected after centrifuging the material. The oxalic acid precipitation is repeated and the resulting precipitate filtered. The precipitate is ashed, dissolved in acid and, after adding iron carrier, the pH is adjusted. The precipitate is retained, dissolved in an acid mixture and passed through an ion-exchange column. A number of eluants are used to remove specific radionuclides from the column. Each eluant is subjected to electrochemical deposition and alpha spectrometry as described above. Appropriate yield tracers including plutonium-243, americium-243, thorium-229 and uranium-232 are used.

6.2 Neptunium-237

Samples are ashed, extracted with hydrochloric acid and, where necessary, iron (III) carrier is added. The solution is made alkaline and the resulting precipitate centrifuged and collected. This precipitate is dissolved in acid and reduced to incipient dryness. After the addition of further acid, the sample is diluted with methanol. Recoveries are determined by the standard addition technique.

6.3 Sulphur-35

Sulphate carrier is added to the sample which is allowed to stand overnight in the presence of nitric acid. The resultant solution is evaporated to incipient dryness, cooled and magnesium nitrate solution added. After dissolution in hot water, the material is transferred to a crucible, evaporated to dryness and ignited to 500 °C. The residue is dissolved in aqueous acid and filtered, collecting the filtrate and washings. The pH of the solution is adjusted and subjected to ion-exchange chromatography. The column is eluted and the resulting eluant raised to boiling point. Barium chloride solution is added and the material centrifuged. The supernatant liquor is removed and the residual solid transferred to a gel scintillator and counted by liquid scintillation spectrometry. Yields are determined by the standard addition technique.

6.4 Technetium-99

Hydrogen peroxide is added to the sample (in liquid form) prior to passing the material down an ion-exchange column. The column is washed with water and eluted. The fraction of interest is extracted into cyclohexanone and the aqueous phase discarded. The organic phase is washed with 1M HCl, water and partitioned with a cyclohexane/water mixture. The aqueous phase is reduced in volume and counted using liquid scintillation spectrometry.

6.5 Strontium-90

Strontium and calcium carriers are added to the sample followed by oxalic acid solution. The pH of the solution is adjusted and, after warming, the resulting precipitate is recovered by centrifuging. The precipitate is dissolved in acid and oxalic acid precipitation repeated. The oxalate is destroyed by heating to 600 °C and the resulting residue is dissolved in acid. Hydrogen sulphide is passed through the solution in the presence of a number of carriers. The supernatant is made alkaline and the hydrogen sulphide treatment repeated. Ammonium carbonate is added to the supernatant and the solution centrifuged. The supernatant is discarded, the carbonates dissolved in acid and the precipitation repeated. The precipitate is dissolved in acid and fuming nitric acid added. The solution is cooled in ice and the precipitate retained. The fuming nitric acid step is repeated and the precipitate dissolved in water. Barium carrier is added and the pH adjusted. The solution is warmed, chromate added and, after centrifuging, the supernatant liquor retained. A precipitation procedure is carried out using fuming nitric acid and the resulting solid dissolved in water. Iron carrier is added and the solution made alkaline, heated and filtered into a clean tube. Yttrium carrier is added and the solution made acidic. Yttrium-90 daughter product is allowed to grow-in and the precipitate retained. The precipitate is dissolved in acid and the hydroxide precipitation repeated twice. The precipitate is recovered and washed with water and methanol. The purified solid is suspended in gel scintillator and counted by liquid scintillation spectrometry.

6.6 Tritium by electrolysis

A suitable volume of sample is distilled and electrolyte added to the distillate. The material is subjected to electrolysis until the required level of pre-concentration is achieved. The remaining solution is distilled and the distillate counted by liquid scintillation spectrometry. Recoveries are determined using low-level tritium standard solutions.

6.7 Uranium analysis

The radionuclide uranium-238 is determined using non-destructive thermal neutron activation analysis. An independent measurement of uranium-235 is performed using delayed neutron analysis. Where appropriate the measurement of uranium-235 and uranium-238 (from an assumption of equilibrium with the decay product thorium-234) is carried out by gamma-ray spectrometry. This latter technique is inherently less sensitive than those methods involving neutron activation reactions. Its application for the measurement of uranium isotopes is limited accordingly.

APPENDIX 14

ENVIRONMENT AGENCY – EFFLUENT MONITORING

Power station	**Sample type**	**Sampling frequency (y^{-1})**	**Analytical requirement**
Dungeness A	FMDT	4 (Quarterly)	Total activity (excluding ^{3}H) by liquid scintillation counting using ^{14}C and ^{137}Cs standards for low and high-energy windows respectively, ^{3}H by distillation, ^{137}Cs.
Dungeness B	FMDT	4 (Quarterly)	Total activity (excluding ^{3}H) by liquid scintillation counting using ^{55}Fe and ^{14}C standards, ^{3}H by distillation, ^{137}Cs, ^{60}Co.
Dungeness B	TWST	4 (Quarterly)	^{3}H and ^{35}S by direct dual channel liquid scintillation counting.
Dungeness A & B	Gas bubblers	1 (Sample from each reactor *ie* 2 per station)	^{3}H and ^{35}S by direct dual channel liquid scintillation counting. ^{14}C by direct liquid scintillation.

APPENDIX 15

ENVIRONMENT AGENCY – SUMMARY FLOWCHART

	Effluent Programme	Environmental Programme
Specification of Monitoring Programme	Responsibility of NCAS (EA) in association with RSR Inspectors.	Responsibility of NCAS (EA) in association with RSR Inspectors.
Collection of Samples	RSR Inspector formally writes to nuclear site operators to require samples to be collected in accordance with the specification. Samples stabilised by the operator in accordance with specification.	Collected by ICI Synetix Services (contractor) in accordance with specification.
Transport of Samples to Laboratory	Labelled sample bottles with consignment note delivered by courier service to LGC.	Driven by ICI Synetix Services after collection.
Control of Samples in Laboratory and Storage	UKAS procedures for control of samples. Given unique laboratory code.	UKAS procedures for control of samples. Given unique laboratory code.
Analysis of Samples and Quality Control	Analysis in accordance with UKAS accredited methods or methods approved by NCAS (EA).	Analysis in accordance with UKAS accredited methods or methods approved by NCAS (EA).
Interpretation and Trending	Examination for unusual results and trends to notify to EA on a quarterly basis.	Examination for unusual results and trends to notify to EA on a quarterly basis.
Reporting of Results to Environment Agency	Report of results produced quarterly along with a report of trends and unusual results.	Report of results produced quarterly along with a report of trends and unusual results.
Results Acceptance	NCAS Programme Manager approves acceptance of results following review.	NCAS Programme Manager approves acceptance of results following review.
Transfer of Results to database & Annual Report "Radioactivity in the Environment"	Undertaken by NNC Ltd under procedures certified to ISO 9001. Data independently checked by NCAS Radiological Assessor.	Undertaken by NNC Ltd under procedures certified to ISO 9001. Data independently checked by NCAS Radiological Assessor.
Archiving	Paper reports are archived for 5 years. Results are available electronically in database. Samples are archived for at least 12 months.	Paper reports are archived for 5 years. Results are available electronically in database. Samples are archived for at least 12 months.

APPENDIX 16

FOOD STANDARDS AGENCY – SCOPE OF NUCLEAR SITE SAMPLING

Measurement	Routine frequency of measurement	Analyses or measurements	Types of material	Detailed species/materials
Aquatic programme				
Analysis of foods	Annually to monthly	Total beta, gamma spectrometry, ^{3}H organic ^{3}H ^{14}C ^{226}Ra ^{90}Sr ^{99}Tc ^{147}Pm $^{134/137}Cs$ Th U transuranics	Fish, crustaceans, molluscs, edible aquatic plants	Cod, plaice, grey mullet, bass, dab, ray, herring, flounder, sea trout, dogfish, whiting, whitebait, fish oil, salmon, sole, spurdog, mackerel, pollack, haddock, crabs, lobsters, squat lobsters, winkles, native oysters, mussels, limpets, whelks, cockles, elvers, Nephrops, pacific oysters, shrimps, prawns, squid, scallops, queens, ormers, toothed winkles, Porphyra, laverbread, samphire, pike, brown trout, rainbow trout, perch and spider crabs
Analysis of indicator materials	Annually to weekly	Total beta, gamma spectrometry, ^{3}H ^{14}C ^{226}Ra ^{90}Sr ^{99}Tc ^{147}Pm $^{134/137}Cs$ Th U transuranics	Water, sediments, salt marsh, seaweeds, aquatic plants and coarse fish	Fish meal, mud, sand, clay, salt marsh, turf, sludge, seawater, freshwater, Fucus spp., Rhodymenia spp., Elodea canadensis, Nuphar lutea, Ascophyllum nodosum, rudd and lugworm
Gamma dose rates	Annually to monthly		On beaches, harbours, marshes, riverbanks, lakesides and boats	
Beta dose rates	Annually to quarterly		On nets, pots, ropes, sediments and saltmarsh	
Contamination survey	Annually to monthly		On beaches	

FOOD STANDARDS AGENCY – SCOPE OF NUCLEAR SITE SAMPLING (cont'd)

Measurement	Routine frequency of measurement	Analyses or measurements	Types of material	Detailed species/materials
Terrestrial programme				
Analysis of foods	Annually to monthly	Total alpha, beta and gamma, gamma spectrometry ^{3}H organic ^{3}H ^{14}C ^{32}P ^{35}S ^{45}Ca ^{55}Fe ^{90}Sr ^{99}Tc Ru ^{131}I ^{129}I ^{147}Pm $^{134/137}Cs$ ^{210}Po U ^{210}Pb transuranics	Milk, crops and animals	Cows' and goats' milk, beef meat, kidney and liver, sheep meat and offal, pig meat and offal, chicken, duck, curlew, pintail, shelduck, teal, pheasant, rabbits, honey, mushrooms, hazelnuts, beetroot, wheat, barley, elderberries, apples, blackberries, strawberries, raspberries, cabbage, sea kale, lettuce, potatoes, runner beans, turnips, leeks, carrots, swede, sprouts, sprout tops, broad beans, kale, peas, cauliflower, pears, spinach, marrow, courgettes, onions, leaf beet, French beans, hares, pigeons, figs and rape oil
Analysis of indicator	Annually to monthly	Total alpha, beta and gamma, gamma spectrometry ^{3}H organic ^{3}H ^{14}C ^{32}P ^{35}S ^{45}Ca ^{55}Fe ^{63}Ni ^{90}Sr ^{99}Tc Ru ^{131}I ^{129}I ^{147}Pm $^{134/137}Cs$ ^{210}Po U ^{210}Pb transuranics	Grass, soil, faeces, dry cloths and animal food	Grass, soil, silage, animal faeces, rape, fodder beet, lucerne, rainwater and dry cloths

APPENDIX 17

FOOD STANDARDS AGENCY
ENVIRONMENTAL MONITORING PROGRAMME
DUNGENESS AREA

1. Aquatic

Location	Sample type	Sampling frequency (y^{-1})	Analytical requirement
Pipeline	Shrimp	2	Gamma spectrometry
Pipeline	Shrimp	2 bulked for 1 analysis	^{14}C [12] Total ^{14}C content
Pipeline	Common Whelk	2	Gamma spectrometry
Pipeline	Common Whelk	2 bulked for 1 analysis	Pu Am Cm ^{90}Sr
Pipeline	Cod	2	Gamma spec. Total ^{3}H
Pipeline	European Sea Bass	1	Gamma spec. Total ^{3}H
Pipeline	European Plaice	2	Gamma spec. Total ^{3}H
Dungeness Inlet	Seawater	2	Total ^{3}H
Rye Harbour	Sandy Mud	2	Gamma dose rate at 1m height, contact beta dose rate
Rye Harbour	Sandy Mud	2	Gamma spectrometry
Rye Harbour	Sandy Mud	2 bulked for 1 analysis	Pu Am Cm
Copt Point	Bladder Wrack	1	^{99}Tc
Hastings Landed	Edible Crab	1	Gamma spectrometry
Hastings Landed	Common Cuttlefish	1	Gamma spectrometry

2. Terrestrial

Location	Sample type	Target collection	Analytical Requirement
2 Local Farms	Milk	Quarterly	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Locally grown (east of site)	Sea Kale	Apr-Jun	Gamma spec. Total ^{3}H ^{14}C ^{35}S ^{55}Fe
Locally grown	Field or Green Beans	Jul-Sep	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Locally grown	Potatoes	Jul-Sep	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Locally grown	Blackberries	Jul-Sep	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Locally grown	Peas	Jul-Sep	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Locally grown	Honey	Jul-Nov	Gamma spec. Total ^{3}H ^{14}C ^{35}S
Vicinity of Power Station	“Dry Cloth”	Monthly	Total alpha Total beta Total gamma

[12] Natural C-14 of sample (kg C per kg of sample x 250 Bq ^{14}C natural per kg C).

APPENDIX 18

FOOD STANDARDS AGENCY – ANALYTICAL METHODS

Radionuclides	Sample type	Method of measurement
^{3}H ^{3}H (organic) ^{14}C ^{32}P ^{35}S ^{45}Ca ^{147}Pm ^{241}Pu	All	Beta counting by liquid scintillation
^{90}Sr	High-level aquatic samples	Cerenkov counting by liquid scintillation
^{90}Sr	Terrestrial and low-level aquatic samples	Beta counting using gas proportional detectors
^{99}Tc ^{210}Pb beta	All	Beta counting using gas proportional detectors
$^{103+106}Ru$ ^{131}I ^{144}Ce $^{134+137}Cs$	Terrestrial samples	Beta counting using gas proportional detectors
^{125}I ^{129}I	Terrestrial samples (13)	Gamma counting by solid scintillation
^{134}Cs ^{137}Cs	Seawater	Gamma counting by solid scintillation
Gamma	Dry cloths	Gamma counting by solid scintillation
^{51}Cr ^{54}Mn ^{57}Co ^{58}Co ^{60}Co ^{59}Fe ^{65}Zn ^{95}Nb ^{95}Zr ^{103}Ru ^{106}Ru ^{110m}Ag ^{125}Sb ^{134}Cs ^{137}Cs ^{144}Ce ^{154}Eu ^{155}Eu ^{241}Am ^{233}Pa 234Th	All	Gamma spectrometry using germanium detectors
^{125}I ^{129}I	Terrestrial samples (14)	Gamma spectrometry using germanium detectors
^{129}I ^{131}I	Aquatic samples	Gamma spectrometry using germanium detectors
U	Terrestrial samples	Activation and delayed neutron counting
^{210}Po ^{226}Ra (15) ^{234}U $^{235+236}U$ ^{238}U ^{237}Np 228Th ^{230}Th ^{238}Pu $^{239+240}Pu$ ^{241}Am ^{242}Cm $^{243+244}Cm$	All	Alpha spectrometry
^{226}Ra	Terrestrial samples	Alpha counting using thin window proportional detectors
Alpha	Dry cloths	Alpha counting using thin window proportional detectors

13 England and Wales.
14 Scotland.
15 Determined by gamma spectrometry in sediment samples near Springfields.

APPENDIX 19

FOOD STANDARDS AGENCY – DATA TRANSFER FLOWCHART