RIFE - 1

Radioactivity in Food and the Environment, 1995

Ministry of Agriculture,
Fisheries and Food, 1996

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

Radioactivity in Food and the Environment, 1995

1996

This is the first joint surveillance report published by MAFF covering information previously issued in the Terrestrial Radioactivity Monitoring Report (TRAMP) and the Aquatic Environment Monitoring Report (AEMR).

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SUMMARY

1. This report is the first in a series which combines the results of the radioactivity monitoring programmes previously published by MAFF in two documents: the 'Terrestrial Radioactivity Monitoring Programme (TRAMP) Report: Radioactivity in food and agricultural products in England and Wales' and the 'Aquatic Environment Monitoring Report: Radioactivity in surface and coastal waters of the British Isles(AEMR).

2. These programmes required the taking of approximately 1500 samples of terrestrial and aquatic foodstuffs together with approximately 3700 samples of environmental indicators and dose rate measurements from sites throughout England and Wales. These samples were subjected to approximately 16000 analyses for their radioactive content or dose rate measurement. The essential conclusion of this report is that foodstuffs produced in England and Wales and seafoods produced in the waters surrounding the British Isles are radiologically safe to eat.

3. The programmes are managed by the Ministry of Agriculture, Fisheries and Food on behalf of the Scottish Office, the Welsh Office, the Department of the Environment for Northern Ireland, the Manx Government and the Channel Island States. They act as a key component of the UK Government's strategy to protect the safety of the food chain and the marine environment. The main objective of the programmes is to verify that radioactivity present in foodstuffs is acceptable and to ensure that the resulting public radiation exposure is within internationally accepted limits. The bulk of the report concerns England and Wales. However, data on the marine environment of the British Isles including Scotland are included to be consistent with earlier reports and because the effects of discharges of liquid effluents are detectable in areas remote from the point of origin.

4. A substantial part of the cost of the programmes is recouped from industries discharging wastes in accordance with the 'polluter pays' principle.

5. Disposals of liquid, gaseous and solid wastes from major nuclear sites in England and Wales are regulated by the Environment Agency using powers in the Radioactive Substances Act, 1993. Disposals from all sites in 1995 were within the authorised limits except where specified in the text.

6. Measurements in 1995 included the analysis of samples of food and other materials from the environment and detection of beta and gamma dose rates in the environment. The results showed that radionuclide concentrations and radiation dose rates were generally similar to those in 1994. However, near Sellafield, superimposed on the general downward trend in radionuclide concentrations due to Sellafield discharges, there were some changes in concentrations of particular radionuclides in the marine environment reflecting operations at the site. These operations included processing of stored wastes and the operation of the Enhanced Actinide Removal Plant (EARP). The Thermal Oxide Reprocessing Plant (THORP) continued its commissioning phase in 1995 and had little effect on food and the marine environment. The results of the monitoring have been interpreted in terms of public radiation exposures using data from food and local surveys to establish 'critical groups' of people likely to be most exposed.

7. Public radiation doses received in 1995 from discharges of radioactive waste are presented in the Summary Table and in Figures 1-3. The exposures are expressed in terms of 'committed effective dose' calculated on the basis of the methodology in ICRP-60. Where appropriate, doses to skin are also given. Exposures were all within the dose limit of 1 mSv for members of the public or the skin dose limit of 50 mSv as appropriate. Figures 1 and 2 present the numerical data in graphical form for aquatic and terrestrial sectors, respectively. Figure 3 combines these data and represents the most exposed group doses for each site from all food and aquatic pathways in 1995.

8. The highest exposures due to the nuclear industry were from discharges of liquid radioactive wastes from Sellafield. Exposures of high-rate fish and shellfish consumers due to artificial radionuclides near Sellafield increased in 1995 (0.12 mSv), as compared with 1994 (0.08 mSv), due to increased consumption of molluscs and increased concentrations of technetium-99 in crustaceans. These individuals also received a dose resulting from discharges from the Albright and Wilson works at Whitehaven. Exposures of people associated with fisheries at Whitehaven, Morecambe Bay and Dumfries and Galloway were similar in 1995 to exposures in 1994. Exposures from people associated with fisheries at Fleetwood reduced because of a reduction in consumption of seafood. These exposures include a contribution due to activity discharged in years prior to 1995.

Summary Table: Estimates of public radiation exposure from discharges of radioactive waste in England and Wales

Establishment	Radiation exposure pathway	Critical group	Exposure, mSv[a]
British Nuclear Fuels plc			
Sellafield and Drigg[b]	Fish and shellfish consumption	Local fishing community	0.12
	Terrestrial foods	Local consumers at Sellafield	<0.081
	"	" " " Drigg	<0.035
	"	" " " Ravenglass	<0.037
	External	Houseboat dwellers (River Ribble)	0.091
	External[c]	Fishermen (Whitehaven)	0.060
	"	Anglers	0.13
	External	"	0.84[d]
	Handling of fishing gear	Local fishing community	0.30[d]
	Porphyra/laverbread consumption	Consumers in South Wales	<0.005
	Trout consumption	Local consumers at Sellafield	0.046
Springfields	External	Houseboat dwellers (River Ribble)	0.091
	"	Anglers	0.042
	" (skin)	"	2.6[d]
	Terrestrial foods[g]	Local consumers	<0.007[f]
Capenhurst	Inadvertent ingestion of water and sediment	Local community	<0.005
	Terrestrial foods	Local consumers	<0.005[f]
United Kingdom Atomic Energy Authority			
Harwell	Fish consumption and external	Anglers	0.017
	Terrestrial foods	Local consumers	<0.005
Winfrith	Fish and shellfish consumption	Local fishing community	<0.005
	Terrestrial foods	Local consumers	<0.005
Nuclear Electric plc			
Berkeley and Oldbury	Fish and shellfish consumption and external	Local fishing community	0.010
	Terrestrial foods	Local consumers	<0.005
Bradwell	Fish and shellfish consumption and external	Houseboat dwellers	0.011
	Terrestrial foods	Local consumers	<0.005
Dungeness	Fish and shellfish consumption and external	Bait diggers	0.008
	Terrestrial foods	Local consumers	<0.013
Hartlepool	Fish and shellfish consumption	Local fishing community	<0.005
	Terrestrial foods	Local consumers	<0.009
Heysham	Fish and shellfish consumption and external	Local fishing community	0.073
	Terrestrial foods	Local consumers	<0.012
Hinkley Point	External	Local fishing community	0.008
	Terrestrial foods	Local consumers	<0.013
Sizewell	Fish and shellfish consumption and external	Local fishing community	<0.005
	Terrestrial foods	Local consumers	<0.008
Trawsfynydd	Fish consumption and external	Local fishing community	0.035
	Terrestrial foods[g]	Local consumers	<0.014
Wylfa	Fish and shellfish consumption and external	Local fishing community	0.005
	Terrestrial foods	Local consumers	<0.006
Defence Establishments			
Aldermaston	Fish consumption and external	Anglers	<0.005
	Terrestrial foods	Local consumers	<0.005[f]
Barrow	External	Local community	0.023
Chatham	External	Houseboat dwellers	0.005
Devonport	Fish and shellfish consumption and external	Local community	0.012
Amersham International plc			
Amersham	Fish consumption and external	Anglers	<0.005
	Terrestrial foods	Local consumers	<0.011
Cardiff	Fish and shellfish consumption and external	Local fishing community	0.012
	Terrestrial foods	Local consumers	<0.027
Abright and Wilson Ltd			
Whitehaven[e]	Fish and shellfish consumption	Local fishing community	0.29

[a] Unless otherwise stated represents committed effective dose calculated using methodology of ICRP-60 to be compared with the dose limit of 1 mSv (see section 6). Exposures due to marine pathways include the far-field effects of discharges of liquid waste from Sellafield. All exposures for terrestrial pathways include a component from radionuclides which were found to be below the limits of detection. Unless stated otherwise, the critical group for terrestrial pathways is represented is represented by the 1 year old age group

[b] The estimates for marine pathways include the effects of liquid discharges from Drigg, but exclude the effects of natural radionuclides. The contribution due to Drigg is negligible. The exposure due to enhanced concentrations of natural radionuclides for seafood consumers in 1995 was 0.21 mSv

[c] Includes a small contribution due to consumption of seafood

[d] Exposure to skin including a component due to natural sources of beta radiation, to be compared with the dose limit of 50 mSv (see section 6)

[e] These estimates include the effects of enhanced concentrations of natural radionuclides but exclude a small contribution from the effects of artificial radionuclides from other sites. They assume a gut uptake of 0.8 for polonium which is based on studies of seafood consumption (see section 6). The exposure due to artificial radionuclides in 1995 was 0.054 mSv

[f] Includes a component due to natural sources of radionuclides

[g] Adults

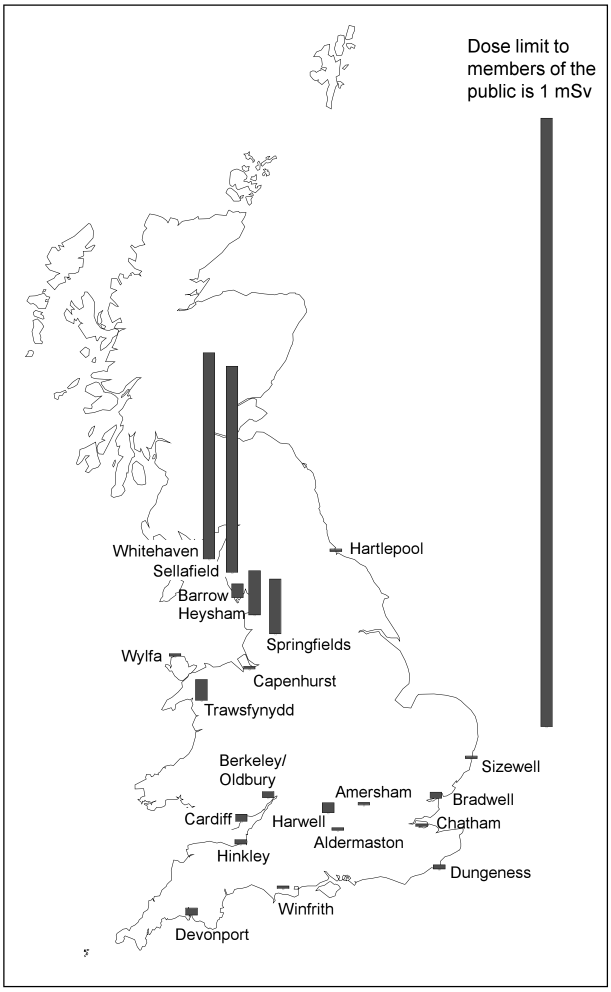

***Figure 1.** Radiation exposures in England and Wales due to liquid radioactive waste discharges, 1995. (Historic discharges from Sellafield have a significant effect on exposures throughout the Irish Sea. Exposures at Whitehaven and Sellafield include the effects of enhanced concentrations of natural radionuclides)*

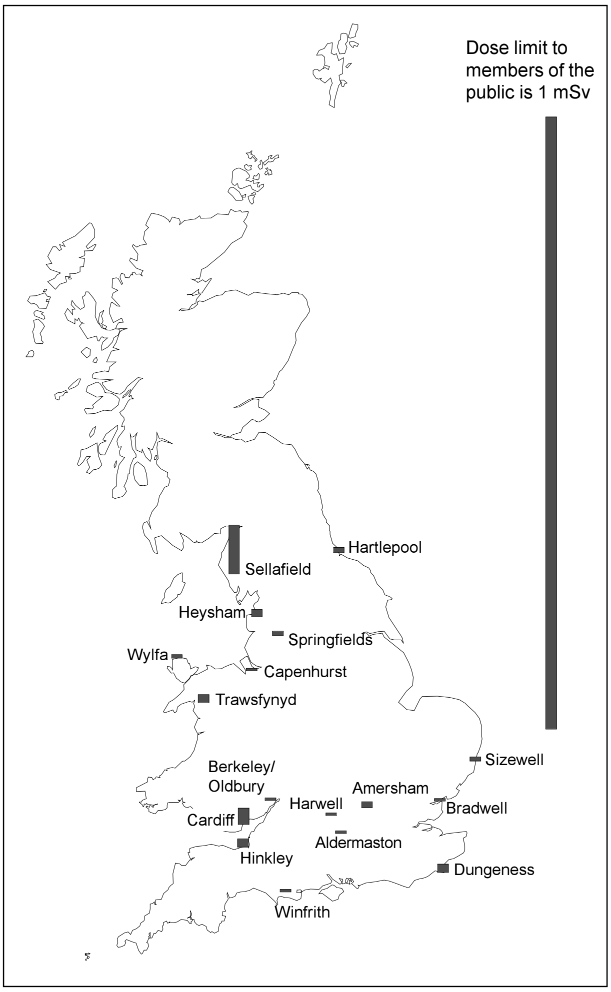

***Figure 2.** Radiation exposures in England and Wales due to gaseous radioactive discharges, 1995*

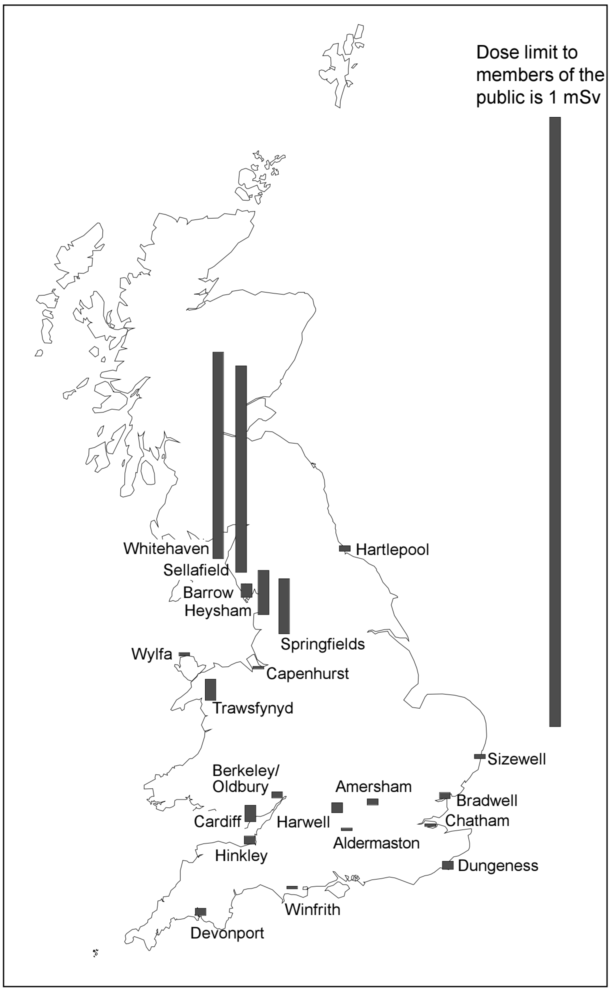

Figure 3. Radiation exposures in England and Wales due to radioactice discharges, 1995. (Historic discharges from Sellafield have a significant effect on exposures throughout the Irish Sea. Exposures at Whitehaven and Sellafield include the effects of enhanced concentrations of natural radio-nuclides)

9. The most exposed group from discharges of gaseous wastes was also at Sellafield. The dose to the most exposed group of terrestrial food consumers, including a contribution from fallout, was less than 0.081 mSv, an increase from the value for 1994 because of a change in the method of assessment to account for the presence of daughter nuclides with some radionuclides and increased levels of sulphur-35 in milk. Consumers of trout from a farm near Sellafield received a dose of <0.046 mSv. Exposures due to consumption of terrestrial foods at all nuclear sites were well within the dose limit of 1 mSv.

10. Those most exposed to external radiation in connection with liquid discharges from Sellafield were a group of anglers who dig their own bait near Sellafield. Their dose in 1995 was 0.13 mSv, similar to the value for 1994. The exposure of the small group of houseboat dwellers in the Ribble estuary reduced from 0.14 mSv (1994) to 0.091 mSv in 1995 because of a reduction in dose rates and occupancies on the boat. All exposures due to artificial radionuclides discharged in liquid wastes were well within the dose limit of 1 mSv.

11. Concentrations in seafood of the key radionuclides discharged from Whitehaven Works (Albright and Wilson Ltd) have reduced further in 1995, as expected, due to earlier reductions in liquid discharges and radioactive decay. As a consequence, exposures of the most exposed group of fish and shellfish consumers due to the enhancement of concentrations of natural radionuclides have reduced. Taking an upper estimate of the gut transfer of polonium, the dose in 1995 was cautiously estimated to be 0.29 mSv compared with 0.34 mSv in 1994. This group also received a dose from discharges from Sellafield. Further reductions in concentrations of radionuclides in shellfish are expected in 1996.

12. No evidence was found for enhancement of radionuclide levels near non-nuclear industrial sites other than at Albright and Wilson Ltd, Whitehaven. However, there was limited evidence to support the observation that tritium is to be found leaching from some landfill sites. The radiological significance of the levels found was negligible. Further monitoring around landfill sites was carried out on behalf of HMIP (HMIP 1995).

13. The collective dose from seafood consumption to the UK and other European populations in 1995 was 3 and 20 man-Sv respectively, similar to the values for 1994. The most significant waste discharges giving rise to collective dose were those of radiocaesium from Sellafield.

14. Regional monitoring showed that exposures on the Isle of Man and the Channel Islands from artificial radioactivity were low, at less than 3% of the dose limit of 1 mSv in the case of the Isle of Man and lower in the Channel Islands. Analyses of general diet throughout England and Wales and foodstuffs produced remote from nuclear sites continued to demonstrate that natural radionuclides are by far the most dominant source of exposure through the food chain.

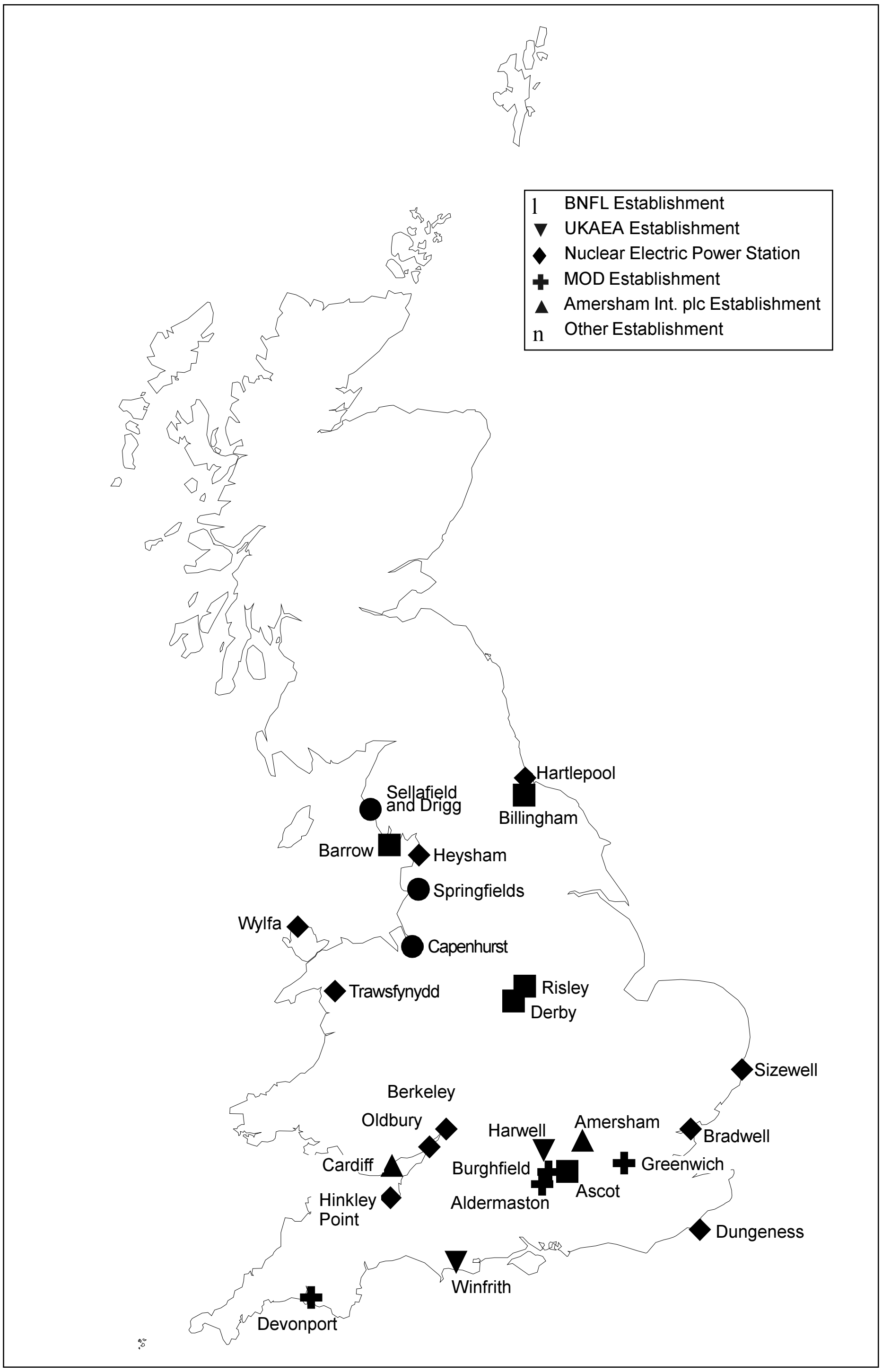

Figure 4. Principal sources of radioactive waste disposal in England and Wales

1. INTRODUCTION

This report is the first in a series which combines the results of the radioactivity monitoring programmes previously published by the Ministry of Agriculture, Fisheries and Food (MAFF) in two documents: the 'Terrestrial Radioactivity Monitoring Programme (TRAMP) Report: Radioactivity in food and agricultural products in England and Wales' (e.g. MAFF, 1995) and the 'Aquatic Environment Monitoring Report: Radioactivity in surface and coastal waters of the British Isles' (e.g. Camplin, 1995).

The data in this report are for 1995 and the combined programme is managed by MAFF on behalf of the Scottish Office, the Welsh Office, the Department of the Environment for Northern Ireland, the Manx Government and the Channel Island States. Together with the monitoring sponsored by Her Majesty's Inspectorate of Pollution [a] (e.g. HMIP, 1995), the programme supports statutory functions under the Radioactive Substances Act, 1993 (United Kingdom - Parliament, 1993) (replacing the Radioactive Substances Act, 1960 (United Kingdom - Parliament, 1960)). It is set up to verify that radioactivity present within foodstuffs is acceptable and to ensure that the resulting public radiation exposure is within internationally accepted limits. The monitoring is independent of similar programmes carried out by nuclear site operators as a condition of their authorisations to discharge radioactive wastes. The bulk of the report concerns the environment of England and Wales and adjacent sea areas. However, data on the marine environment of the whole of the British Isles are included to be consistent with earlier reports and because the effects of discharges of liquid effluents are detectable remote from their point of origin. Where appropriate, the monitoring data for nuclear sites are supplemented by results from other projects related to the behaviour of radioactivity in the environment. A summary of all monitoring programmes as undertaken by nuclear site operators and local and central government is available (Cotter *et al.*, 1992) and details of monitoring programmes specifically related to Scotland have been published (e.g. Scottish Office, 1996).

To set the monitoring results from the programme in context, radioactive waste disposals from nuclear establishments in England and Wales in 1995 are first summarised (Tables 1, 2 and 3). Before the results are presented, an explanatory section gives details of methods of sampling, analysis and presentation and explains how results are interpreted in terms of public radiation exposures. Information on liquid radioactive waste discharges from nuclear sites in Scotland and associated environmental monitoring is contained in Appendix 1. A glossary of terms and abbreviations is provided at Appendix 2.

2. DISPOSALS OF RADIOACTIVE WASTE

2.1 Radioactive waste disposal from, and in, sites on land

Data on radioactive waste disposals are published annually by the Department of Environment (Department of the Environment, 1996), the latest available publication being for the year 1994. Details of the discharges from individual sites are available from the Environment Agency. A summary of 1995 discharges is included here and this enables the results of monitoring presented in this report to be considered in the context of the relevant disposals. The sites which are the principal sources of waste containing man-made radionuclides are shown in Figure 4 for England and Wales. Our programme includes monitoring at each of these sites. For completeness, it should be noted that small disposals of radioactive waste are also authorised from other sites such as hospitals, chemical works and research establishments. Small amounts of solid waste are also disposed of in specified landfill sites. In general these disposals are so insignificant that environmental monitoring of their effects is not required for individual sites. Enhanced levels of radioactivity in foodstuffs resulting from discharges from such sites would be detected within the regional samples.

Tables 1, 2 and 3 list the principal disposals of liquid, gaseous and solid radioactive waste respectively from nuclear establishments in England and Wales during 1995. The Tables also list the disposal limits which are authorised or, in the case of Crown operators, administratively agreed. In some cases, the authorisations specify limits in greater detail than can be summarised in a single table: in particular, periods shorter than one year are specified at some sites. The authorised limits are usually very much lower than the levels of activities which could be released without exceeding the dose limits which are recommended by the International Commission on Radiological Protection (ICRP), and embodied in national policy (United Kingdom - Parliament, 1995a). The percentages of the authorised (or agreed) limits taken up in 1995 are also stated in the Tables. These indicate that disposals from all sites were within the limits set by the Authorities (see also section 9.9).

Where changes in the rates of disposal in 1995 have materially affected the levels of radioactivity in the environment, comments are made to this effect in the relevant part of the subsequent text.

[a] *With effect from April 1996, this HMIP function has been transfered to The Environment Agency.*

2.2 Solid radioactive waste disposal at sea

In addition to receiving most of the liquid discharges, the marine environment has also, in the past, received packaged solid waste of low specific activity, mainly disposed of in an area of the deep Atlantic Ocean. The most recent such disposal was in 1982. The environmental impact of the deep ocean disposals is determined by mathematical modelling and has been shown to be negligible (OECD (NEA), 1985). Disposals of small amounts of waste also took place from 1950 to 1963 in a part of the English Channel known as the Hurd Deep. The results of environmental monitoring of this area in 1995 are presented in Section 16, which confirms the negligible radiological significance of these disposals.

3. SAMPLING PROGRAMME

The basis for the main part of the sampling programme is to provide data permitting calculation of exposures to members of the public for comparison with national limits. In this context sampling is taken to include not only collection of samples from the environment for laboratory analysis (which is mainly directed at food pathways), but also direct measurements in the environment of dose rates to assess external exposure pathways. Subsidiary objectives for the programme are: (i) to establish a baseline from which to judge the importance of accidental releases of radioactivity should they occur; (ii) to determine whether undeclared releases of radioactivity have occurred from sites; and (iii) to provide information on radioactivity in the diet of the general population and to aid calculation of collective radiation exposures.

Sampling is generally focused at nuclear sites licensed by the Health and Safety Executive under the Nuclear Installations Act, 1965 (United Kingdom - Parliament, 1965) where the programme serves to provide information to assist government bodies to fulfil their statutory duties under the Radioactive Substances Act, 1993 [b] .

However, additional sampling is carried out remote from nuclear sites in order that the government bodies can establish the general safety of the foodchain and the environment as affected by, for example, atmospheric fallout from past nuclear weapons testing and the accident at Chernobyl and discharges from nuclear sites in other nations.

The combined programme can be divided into four main sectors largely on the basis of the origin of radioactivity in the environment:

1. Nuclear sites
2. Other industrial and landfill sites
3. Chernobyl fallout
4. Regional monitoring

The scope of these sectors is summarised in Table 4 and described in the following sub-sections.

3.1 Nuclear sites

Nuclear sites are the prime focus of the programme as they are responsible for the largest discharges of radioactive material. Monitoring is carried out in relation to each of the given sites in Figure 4. Most sampling and direct monitoring is conducted in the site's immediate vicinity. However, because of the ability to detect the effects of discharges of liquid effluent from BNFL Sellafield in many parts of north-European waters, the programme for this site extends beyond national boundaries.

Whilst the development of aquatic and terrestrial components of the programme has historically taken place under separate management, the common goal in both areas is the estimation of exposures for those small groups of people who are most at risk from disposals of radioactive waste. In the aquatic environment, the pathways which are most relevant to such a programme are ingestion of seafood, freshwater fish and drinking water and external exposure from contaminated materials. In the terrestrial environment they are ingestion of terrestrial foods, inhalation of airborne activity and external exposure from material in the air and deposited on land. The drinking water pathway is generally considered as part of HMIP's programme (HMIP, 1995). Inhalation of airborne activity and external exposure from airborne material and surface deposition are difficult to assess by direct measurement and are more amenable to assessment using environmental models. The main thrust of the monitoring is therefore directed at foodstuffs of all kinds and external exposure on the shores of seas, rivers and lakes.

3.1.1 The aquatic programme

The general scope of the aquatic programme in 1995 is summarised in Table 5. The detailed programme can be deduced by reference to the results given later in this

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[b] *Ministry of Defence sites are excluded from statutory regulation under the Radioactive Substances Act, 1993 although similar controls are exercised by administrative means. In April 1996, the distribution of functions within government bodies was amended by the Environment Act, 1995 (United Kingdom - Parliament, 1995b).*

report. The two main components were: (i) sampling and laboratory analysis of a wide range of seafood and indicator materials; and (ii) direct measurements of external dose rates in areas of known or suspected contamination. In both cases the frequency of measurement is dependant on the level of environmental impact from the source under scrutiny, the intervals between measurements varying between 1 month and 1 year. In addition, large-area contamination monitoring is carried out along beaches at selected sites to establish whether there is any unusual localised radioactivity which may be missed by the sediment sampling and measurement regime which is by definition selective.

The types of material sampled and the locations where samples are taken from are chosen to be representative of existing exposure pathways. Knowledge of such pathways is gained from local habits surveys and other sources. As a consequence the programme varies from site to site and, indeed from year to year, according to local circumstances. For example, shrimps are an important fishery at Hinkley Point and are a key foodstuff in the programme at this site. At Springfields very little commercial fishing takes place and the bulk of the monitoring addresses external exposure pathways.

Measurements of indicator materials, such as sediments and seaweeds, whilst less directly relevant to dose, still perform an important function by, for example, providing information on trends in contamination levels at a site. These materials can concentrate particular radionuclides and can offer a cost-effective means of measurement. In the case of sediments, there is an immediate use for activity concentration data in assessments. Such data can be used to help distinguish contributions to the overall dose rates from artificial and natural radionuclides and different sources of artificial radioactivity.

3.1.2 The terrestrial programme

The general scope of the terrestrial programme in 1995 is summarised in Table 5. The main focus of this programme is the sampling and analysis of foodstuffs which may be affected by gaseous discharges although in some cases where food availability is limited, environmental indicator materials such as grass are monitored in place of food. Grass and soil are also sampled and analysed under obligations under the Euratom Treaty (see section 12.5).

The types of foodstuff sampled are chosen on a site by site basis to reflect local availability, however, the basis of the choice is to provide information on the main components of diet; milk, meat and cereals, and on products most likely to be contaminated by discharges, such as leafy green vegetables or soft fruit. Minor foods such as mushrooms and honey, which are known to accumulate radioactivity in some circumstances, are also sampled when available.

For monitoring purposes cows' milk is generally the most important foodstuff as grass is an efficient collector of atmospheric contaminants and many of the more important radionuclides are rapidly passed from grass into milk. In addition, milk is a convenient product to regularly sample and analyse and is an important part of the diet, especially for young children and infants. In addition cows graze a large area of pasture and therefore the monitoring of milk provides a method of carrying out surveillance of large areas. For most analyses weekly collections are bulked to provide four quarterly samples for analysis each year, although some analyses such as sulphur-35 and carbon-14 may be carried out monthly. The frequency of analysis of other foodstuffs is generally annual in order to allow for as wide a range of sample types as possible. Samples are collected from locations as close to the sites as practicable as these will show the highest levels of contamination. In the case of milk, sampling may take place at several farms and these are labelled either as 'near' or 'far' in the tables of results depending on their distance from the site. The threshold for distinguishing between near and far farms is generally 8 km.

The analyses carried out on terrestrial samples reflect the relative magnitude of radionuclide discharges through the gaseous route and the transfer processes which exist for terrestrial pathways. Analysis of grass and soil is carried out in accordance with the requirements under Article 35 of the Euratom Treaty. Results are sent to the Joint Research Council in Italy for incorporation into the Radioactivity Environmental Monitoring database.

'Dry cloth' detectors comprise a cloth mounted on a frame. They are positioned at several locations around each nuclear site and are analysed for alpha, beta and gamma activity each month. They provide a simple method of sampling airborne activity and results are produced quickly to provide an indication of gross changes in discharge. If such changes are found then sampling of materials which can provide a quantitative assessment of food chain impact is considered.

3.2 Industrial and landfill sites

Whilst the main focus of the combined programme is the nuclear industry, a watching brief is kept on other activities which may have a radiological impact in the food chain. This part of the programme considers the impact of discharges of natural radionuclides from chemical works and of disposal into landfill sites other than at the BNFL disposal site at Drigg.

A limited number of industrial sites are chosen for study because either they are known from previous research to have measurable impact on the environment or they represent a type of industrial activity which has potential effects on the environment. These sites do not require licensing under the Nuclear Installations. In 1995, the chemical works studied were at Whitehaven in Cumbria, where discharges of liquid effluent containing natural radionuclides have been shown to increase exposures through seafood consumption (Camplin *et al.*, in press), at Eggborough in North Yorkshire (a coal-fired power station), at Ellesmere Port in Cheshire (an oil refinery) and at Milford Haven in Pembrokeshire (an oil refinery). In the case of the Whitehaven site, the survey was directed at seafood sampling and analysis. At the other sites monitoring of grass, soil or animals took place because the main interest is in any possible terrestrial food chain impact.

The landfill sites studied were in Lancashire, Cleveland, Gwynedd and Cambridgeshire. These landfill sites which are amongst those licensed to receive very low levels of radioactivity for controlled burial are studied to assess the extent, if any, of the contamination leaching from the site and re-entering the terrestrial environment and hence the foodchain.

3.3 Chernobyl fallout

The main effort to monitor the effects of the Chernobyl accident in 1986 was in relation to the continuing restrictions on the movement and sale of sheep in Cumbria and North Wales. Monitoring of other foodstuffs is now at a much reduced rate as levels have declined since the accident, but there remains a small scale survey of caesium radionuclides in freshwater fish taken from a few upland lakes.

3.4 Regional monitoring

In addition to the previous programmes which address specific sources of contamination in England and Wales, we also consider the levels of radionuclides in the environment more remotely from these sources as an indication of general contamination of the food supply. The component parts of this programme are:

- sampling of milk and crops;
- dietary surveys;
- monitoring of the Isle of Man and the Channel Islands;
- seawater surveys.

3.4.1 Milk and Crops

The milk sampling is carried out within England, Wales and Northern Ireland in two networks: a ‘sparse’ network of 3 dairies where samples are determined to a significantly lower level of detection than is routine; and a ‘dense’ network of 27 dairies which affords nation-wide coverage at higher limits of detection. Samples are taken monthly and are reported to the EU to allow comparison of results with those from other European countries.

The crop sampling complements the regional dairy programme. Samples are taken from twenty locations covering ten regions throughout England and Wales and the results give an indication of background levels of radioactive contamination from natural and anthropogenic sources (weapons tests and Chernobyl fallout) for comparison with samples collected from around nuclear sites.

3.4.2 Total Diet Study (TDS)

The purpose of the dietary surveys is to provide information on radionuclides in the general food supply to supplement that for other contaminants. Representative mixed diet samples are collected from nine regions throughout England and Wales. Each diet sample is prepared as for consumption and combined in amounts which reflect their relative importance in the average UK diet.

3.4.3 Isle of Man and the Channel Islands

Monitoring on the Isle of Man for terrestrial foodstuffs is carried out on behalf of the Department of Local Government and the Environment. It comprises sampling of a range of foodstuffs and analysis for Chernobyl, Sellafield and Heysham related radionuclides. Monitoring of seafood is primarily directed at the effects from Sellafield.

Channel Islands monitoring is carried out on behalf of the Channel Island States. It comprises sampling and analysis of seafood and indicator materials as a measure of the potential effects of UK and French discharges into the English Channel and also of historic disposal of solid waste in the Hurd Deep.

3.4.4 Seawater survey

Seawater surveys are carried out in the Irish Sea, Scottish waters and the North Sea to provide information on radionuclide levels and fluxes in the coastal seas of northern Europe. Such information is used to support international studies of the health of the seas under the aegis of the Oslo and Paris Conventions (OSPAR, 1993a) to which the UK is a signatory. These surveys are mounted using research vessels every few years and are supplemented by a continuous small scale programme of spot sampling of seawater at coastal locations.

4. METHODS OF MEASUREMENT

There are two basic types of measurement made: (i) samples are collected from the environment and analysed for their radionuclide content in a laboratory; and (ii) dose rates are measured directly in the environment.

4.1 Sample analysis

The analyses carried out on samples vary according to the nature of the source under investigation. The types of analysis can be broadly categorised in two groups: (i) gamma spectrometry; and, (ii) radiochemical methods. The former is a cost-effective method of detecting a wide range of radionuclides commonly found in wastes and is used for most samples. The latter comprises a range of analyses involving chemical treatments to isolate the radionuclides under study. They are sensitive methods but costly. They are therefore only used when there is clear expectation that information is needed on specific radionuclides which are not detectable using gamma spectrometry.

Currently four laboratories analyse samples in the programmes described in this report. DFR is responsible for analysis of aquatic samples and of dry cloths, VLA and NRPB for gamma spectrometry and radiochemistry of terrestrial samples excluding uranium analysis and CARE for uranium analysis of terrestrial samples. Each laboratory operates a quality control procedure to the standards required by MAFF involving regular calibration of detectors and intercomparison exercises with other laboratories. The methods of measurement used are summarised in Table 6.

Corrections are made for the radioactive decay of radionuclides between the time of sample collection and measurement in the laboratory. This is particularly important for radionuclides with relatively short half-lives such as 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 ingrowth of activity 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 protactinium-233 and thorium-234.

The analysis of foodstuffs is carried out on that part of the sampled material which is normally eaten, e.g. the shells of shellfish and the pods from legumes are usually discarded before analysis. Foodstuff samples are prepared in such a way so as to minimise losses of activity during the analytical stage, e.g. 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. However, these losses are to be expected in the normal cooking process for the foodstuff.

4.2 Measurement of dose rates

Measurements of gamma dose in air over intertidal areas are normally made at 1 m above the ground using Mini Instruments [c] environmental radiation meters type 6-80 with compensated G-M tubes type MC-71. When the human activity resulting in exposure justifies it, for example for people living on boats 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.

4.3 Dry Cloths

The dry cloth programme provides a simple and cheap method of sampling airborne radioactive contamination around each of the major nuclear licensed sites. The dry cloth assembly consists of a v-shaped cloth mounted to pivot on a 2 metre rod. The assembly is set up in a relatively exposed 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. Each set of results is carefully examined so that any unusual levels of activity can be followed up by further sampling or investigation at the site.

5. PRESENTATION OF RESULTS

The tables of monitoring results contain summarised values of observations obtained during the year under review. Where more significant figures are provided by the contributing laboratories, the data are generally rounded to two significant figures but it should be noted that values near to the limits of detection will not have the precision implied by using two significant figures. Observations of a given quantity may vary throughout the year; in general, any variations are larger than the analytical uncertainty inherent in the observations. The variations may, for example, be due to changes in rates of discharge or to different conditions in the receiving environment. The presentation of the summarised results reflects the purpose of this monitoring which is interpreted in terms of public radiation exposures. The method of interpretation is described more fully in Section 6. The appropriate integration period for comparison with recommended limits is one year; standard practice is to combine annual rates of consumption or occupancy of the small group of people who are the most exposed (the critical group) with the arithmetic means of observed radioactivity

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[c] *The reference to proprietary products in this report should not be construed as an official endorsement of these products, nor is any criticism implied of similar products which have not been mentioned.*

concentrations or dose rates, respectively, during the year at the appropriate locations. The use of, for example, the one-off highest observed radioactivity concentration, where a series of measurements have been made over the year, with an annual consumption rate would not generally provide a realistic basis for comparison with the recommended limits. However, in the case of terrestrial foods excluding milk, such as meat and potatoes, it is recognised that the potential for storage of foods harvested at a particular time has to be taken into account. In such cases, we have presented the maximum concentration observed of each radionuclide in 1995 as well as the mean value. The maximum is labelled 'Max.' in the tables and forms the basis for the assessment of dose. For milk samples, the appropriate quantity for use in assessments is the arithmetic mean at an individual farm where the highest concentrations are observed. This is also labelled 'Max.' in the tables to distinguish it from the values which are averaged over a range of farms.

The tables of concentrations are based on three types of results for individual samples. These are: (i) positively detected values above the detection limits; (ii) values at the minimum reporting level (MRL) or limit of detection (LoD); and (iii) results which are 'not detected' (ND) by the methods used. In the case of the latter category, an ND result is indicated for aquatic samples when the uncertainty in the measurement due to counting statistics exceeds a threshold value. 'Less than' values are reported at the LoD or the MRL for terrestrial samples when the radionuclide is one which is likely to be discharged or when a positive result is detected in any other sample from the site in 1995. Limits of detection are governed by various factors relating to the measurement method used and these are described in earlier reports (MAFF, 1995). The minimum reporting level is a quantity related to the radiological significance of a particular concentration of activity. In certain cases, whilst a limit of detection may be relatively low, the requirements for reporting from analytical laboratories are defined at a higher level, that is the MRL. The concepts and values of MRL's are discussed further in earlier reports (e.g. MAFF, 1995).

When assembling data in the tables of concentrations from the analytical laboratories, for calculation of doses values to be included are calculated assuming that 'less than' activities are present in the sample at 'less than' levels for those nuclides which are specified in the discharge authorisation. If a result is 'not detected' then the activity is taken to be nil.

Uncertainties in the results are reported in the tables where appropriate. For all samples except dry cloths, the uncertainties are due to counting statistics and are expressed at the 95% confidence interval. When results in the tables wholly comprise 'less than' or 'not determined' results, no uncertainties are quoted. However when they include such results, the combined uncertainty for a mean or maximum result is calculated assuming the uncertainty for an individual sample is nil if the result for that sample is not positive. The combined uncertainties are calculated by taking the square root of the sum of squared uncertainties divided by the number of observations.

The majority of the analyses undertaken of terrestrial foodstuffs are carried out to routine LoD's and MRL's which are chosen to represent a small percentage of the dose limit for members of the public. In some cases it is useful to carry out analyses to below these routine levels to provide information on the actual concentrations of activity present and therefore facilitate more realistic assessment of activity intake by the local population and to illustrate geographical variations and time trends in results. Such results are labelled 'sub-sets' in the tables.

The results for certain measurements, particularly concentrations of alpha, beta, gamma, carbon-14 and uranium-238 and thorium-232 decay chains and dose rates of beta and gamma radiation, include a contribution due to natural radioactivity. Where appropriate, the assessment of exposures takes into account these contributions as discussed in Section 6.

The tables of results give an indication of the number of observations made for each material. For measurements of dose rates, each observation consists of the mean of a number of individual instrument readings at a given location.

The number of farms which are sampled to provide information on activities in milk are indicated in the tables of results. Otherwise, the number of sampling observations in the tables of concentrations refers to the number of samples which were prepared for analysis during the year. In the case of small animals such as molluscs, one sample may include several hundred individual animals. The number of sampling observations does not necessarily indicate the number of individual analyses carried out for a particular radionuclide. In particular, determinations by radiochemical methods are sometimes carried out less frequently than those by gamma spectrometry. However, the results are based on bulking of samples such that the resulting determination remains representative.

In keeping with normal practice, the concentrations of very short-lived (<3 days half-life) radionuclides which are supported by their parents are not reported in the tables. However, the concentrations of parents are quoted and it can be assumed that the concentrations of the daughter products are approximately equal to those of the parents. Examples of such very short-lived radionuclides are yttrium-90, rhodium-103m, rhodium-106m, barium-137m and protactinium-234m which are formed by decay of, respectively, strontium-90, ruthenium-103, ruthenium-106, caesium-137 and thorium-234. Account is taken of the presence of these daughter nuclides when performing the calculations of exposure.

6. ASSESSMENT OF RESULTS

6.1 Radiation protection standards

The monitoring results in this report are interpreted in terms of radiation exposures of the public. The standards against which these exposures are judged are embodied in national policy on radioactive waste (United Kingdom - Parliament, 1995a). The National Radiological Protection Board (NRPB) advises the UK Government on appropriate standards, including the recommendations of the ICRP. Current UK practice relevant to the general public is based on the recommendations of the ICRP as set out in ICRP Publications 26 (ICRP, 1977) and 60 (ICRP, 1991). The Euratom Directive on basic radiation safety standards (Commission of the European Communities, 1980), with which UK legislation complies, is based on the recommendations of ICRP-26, but has been revised to take account of the changes in radiological protection criteria recommended in ICRP-60; new United Kingdom legislation will be promulgated in due course. The International Atomic Energy Agency (IAEA) and its related inter-governmental organisations have now published their own, revised, Basic Safety Standards for Radiation Protection based on ICRP-60 (IAEA, 1996).

The ICRP-60 dose limitation system for practices involving radiation includes, within appropriate dose limits to individuals, the requirement that 'all exposures shall be kept as low as reasonably achievable...' (ALARA). This requirement involves consideration of collective, as well as individual, doses in radiological control procedures. Collective doses from radioactive waste discharges are kept under review as described later and by NRPB (Hughes and O'Riordan, (1993)). The ICRP and the NRPB do not recommend a dose limit for populations; such a limit might be regarded as suggesting the acceptability of a higher population exposure than may be either necessary or probable.

The condition that doses should meet the ALARA objective is subject to compliance with appropriate individual dose limits. Control of individual exposures is intended to limit stochastic effects (i.e. those whose probability depends on the dose) to an acceptable level and to prevent non-stochastic or deterministic (threshold) effects. For stochastic effects, it is recommended that the risk should be equal whether the whole body is irradiated uniformly or non-uniformly; weighting factors proportional to the risk are defined for different organs. The weighted sum of organ doses is called effective dose in ICRP-60. Exposures from intakes of radioactivity can continue for a number of years, depending upon body retention time. The ICRP-60 committed effective dose represents the integrated exposure following an intake. The maximum dose accepted by the UK Government (United Kingdom - Parliament, 1995a) is 1 mSv in a year; this limit applies to the sum of the effective dose resulting from external exposure during one year and the committed effective dose from that year's intake of radionuclides. ICRP-60 distinguishes between 'practices' which add exposures, can be controlled and to which the dose limits apply, as opposed to 'interventions' which reduce exposures from a pre-existing situation and to which the dose limits do not apply. However, it is accepted that exposures arising from past controlled releases should be included in any comparison with the dose limit to avoid any relaxation of the control of public exposure presently exercised. The dose limitation criteria for members of the public apply at each site to the mean dose received by 'critical group', which is that small group of people who, because of their habits and other aspects of behaviour which affect the doses received, are the most exposed.

In this report, the committed effective doses to the most exposed groups in 1995 calculated from the monitoring data are therefore compared with the dose limit of 1 mSv. For external exposures, specific non-stochastic (deterministic) limits are appropriate. For example, the ICRP continues to recommend (ICRP, 1991) the limit for skin of 50 mSv in a year; this limit is applicable, for example, in the case of handling of fishing gear.

A new recommendation in ICRP-60 is that optimisation should be subject to appropriate constraints which apply within the overall limits. The UK Government has accepted that the dose constraint for a single new source should not exceed 0.3 mSv $year^{-1}$ and that, in general, it should be possible for existing plant to be operated so that the dose from a controlled source does not exceed 0.3 mSv $year^{-1}$. In cases where the 0.3 mSv dose constraint cannot be met the operator must demonstrate that the doses resulting from the continued operation of the plant are as low as reasonably achievable and within the range of tolerable risk. In addition, a 'site constraint' of 0.5 mSv $year^{-1}$ should apply to current and future operations from a number of sources with contiguous boundaries at a single location when the site cannot be optimised as an integral whole. The use of constraints is suitable for predictive assessments which do not include the effects of past discharges, but for those based on monitoring data, which may include the effects of several sources and past operations, use of the dose limit is appropriate.

6.2 Methods and data

Calculations of exposures of members of the public from waste disposal are based on the environmental monitoring data for 1995. These data provide information on two main pathways: (i) ingestion of foodstuffs; and (ii) external exposure from contaminated materials in the aquatic environment. In both cases, the assessment sets out to estimate exposures from these pathways for potential critical groups, that is the groups of people who are likely to be most exposed. There are three factors to consider in the assessment of the ingestion pathway: (i) the concentrations of radionuclides in foodstuffs; (ii) the amounts of food eaten; and (iii) the dose coefficients relating an activity intake to a dose.

In nearly all cases, the activities in the media are determined by monitoring and are given later in this report. The Sellafield and Isle of Man related terrestrial assessments are supplemented by information from models (see Appendix 6). In all cases the concentrations chosen for the assessment are intended to be representative of the intakes of the most exposed in the population. All of the concentrations where a positive result was determined are included irrespective of the origin of the radionuclide. In some cases this means that the calculated exposures include contributions due to discharges from other sites as well as from weapon test fallout and activity deposited following the Chernobyl accident. For aquatic foodstuffs, the mean concentrations from the areas where harvesting of seafood near the site in question is known to take place are used. Positive determinations are often found for aquatic samples. Therefore, where a nuclide is ‘not detected’, it is assumed that its concentration is nil. For milk, the mean concentrations at a farm close to site are taken. The farm is chosen by reference to the data on concentrations such that the highest values of any farm are used in the assessment. This procedure accounts for the possibility that any farm close to a site can act as the sole source of supply of milk to high rate consumers. For other foodstuffs, the maximum concentrations are selected for the assessment to allow for the possibility of storage of food harvested at a particular time when the peak levels in a year may have been present in the environment.

Whereas positive determinations are generally found for aquatic samples, this is not the case for terrestrial samples. It is therefore more important to take account of the possibility of activity being present when no positive determination is found, albeit at a level below the limit of detection or minimum reporting level. Such a possibility is taken into account by assuming that all radionuclides which are specified in the discharge authorisation, or have been detected in other samples at the site and are reported as being ‘less than’ a certain level, are indeed present at that level. This will ensure that estimated exposures are unlikely to be understated.

The amounts of seafood consumed are determined by site specific habits surveys. Data are collected primarily by direct interviews with potential high-rate consumers who are often found in fishing communities. Techniques have included the use of consumption logging sheets (Leonard *et al*., 1982; Leonard, 1984) and consumption rate data have been interpreted using techniques based upon ICRP recommendations (Hunt *et al*., 1982) to select appropriate groups of higher-rate consumers. Consideration of children’s consumption rates has been included in this selection process (Leonard and Hunt, 1985).

The amounts of other food consumed (e.g. milk) are derived from recent national surveys of diet and are grouped for three age groups, adults, 10 year old children and 1 year old infants (Byrom *et al*., 1995). For each food type, consumption rates at the 97.5th percentile of consumers have been taken to represent these people who consume a particular foodstuff at higher than average levels. For foodstuffs where there is a marked variability in local availability, for example honey, or in personal preference, for example offal, diet surveys undertaken among local populations can provide additional data (Stewart *et al*., 1990). A programme of such surveys is being undertaken by MAFF around nuclear sites. However, it has been found that when a variety of staple foodstuff consumption rates are examined, the contribution of cows’ milk in the infant diet is generally the single most important pathway for radionuclide intake.

The foodstuff consumption rates are given in Appendix 3.

The assessment of exposures through consumption of terrestrial foods is based on the assumptions: (i) that the foodstuffs eaten by the most exposed group which are most affected by site operations are those that are sampled for the purposes of environmental monitoring; and (ii) that the rates of consumption of such foodstuffs are sustained wholly by local sources. The two food groups resulting in the highest dose are taken to be consumed at ‘critical group’ consumption rates, while the remainder are consumed at average rates. The choice of two food groups at the higher consumption rates is based on statistical analysis by MAFF of national diet surveys which showed that only a very small percentage of the population were critical rate consumers in more than two food groups (Day & Rees, personal communication). Locally grown cereals are not considered in the assessment of exposures as it is considered highly unlikely that cereals will be made into locally consumed (as opposed to nationally consumed) foodstuffs and consumed at the critical group rates.

Dose calculations for intakes of radionuclides are based on committed effective doses per unit intake (dose coefficients) taken from:

(i) ICRP Publication 67 (ICRP, 1994)
(ii) ICRP Publication 69 (ICRP, 1995) and
(iii) Phipps *et al.* (1991)

Where there is a choice of dose coefficients in the source references, the most recent information is used. The dose coefficients used in this report are provided in Appendix 4 for ease of reference.

The dose assessments include consideration of children and the use of appropriate gut transfer factors. Where there is a choice of gut transfer factors for a radionuclide we have generally chosen the one which results in the highest predicted exposure. However, we have also taken into account specific research work of relevance to the foods considered in this report. This affects the assessments for polonium, plutonium and americium radionuclides.

The current ICRP advice for polonium is that a factor of 0.5 is appropriate for dietary intakes by adults (ICRP, 1994). A study involving the consumption of crab meat containing natural levels of polonium-210 has suggested that the factor could be as high as 0.8 (Hunt and Allington, 1993). Estimates of the exposures due to polonium intake have therefore been calculated using the conservative assumption that a factor of 0.8 applies to all seafood. We have retained a factor of 0.5 for other food.

Studies using adult human volunteers have suggested a factor of 0.0002 in connection with the consumption of plutonium and americium in winkles from near Sellafield (Hunt *et al.,* 1986, 1990). For these and other actinides in food in general, the NRPB considers a gut transfer factor of 0.0005 to be a reasonable best estimate (NRPB, 1990). In this report, when estimating doses to consumers of winkles from Cumbria, a gut transfer factor of 0.0002 is used for plutonium and americium. For other foods and for winkles outside Cumbria the factor of 0.0005 is used for these radioelements.

In the assessment of external exposure there are two factors to consider: (i) the dose rate from the source and (ii) the time spent near the source. In the case of external exposure to penetrating gamma radiation, uniform whole body exposure has been assumed. The measured quantity is air kerma rate. When interpreting this in terms of radiological effect, an air kerma rate of 1 mGy h^{-1} has been taken as producing an effective dose equivalent rate of 0.87 mSv h^{-1} (Spiers *et al*., 1981). This factor does not change significantly for effective dose under ICRP-60 (NRPB, 1993). For external exposure of skin, the measured quantity is contamination in Bq cm^{-2}. In this case, dose rate factors in Sv $year^{-1}$ per Bq cm^{-2} are used which are calculated for a depth in tissue of 7 mg cm^{-2} (Kocher and Eckerman, 1987). The exposure of gonads from beta radiation is assessed using the methods described by Hunt (1992). The times spent near sources of external exposure are determined by site specific habits surveys in a similar manner to consumption rates of seafood. The occupancy and handling times are given in Appendix 3.

When assessing the man-made effect on external exposures to gamma radiation and internal exposures due to ingestion of carbon-14 and radionuclides in the uranium and thorium decay series in seafood, estimates of dose rates and concentrations, as appropriate, due to natural background levels are subtracted. Background carbon-14 concentrations in terrestrial foods are also subtracted. The estimates of background concentrations are given in Appendix 5. On the basis of measurements made previously as part of the programmes reported here, the gamma dose rate backgrounds in the aquatic environment were taken to be 0.05 μGy h^{-1} for sandy substrates, 0.07 μGy h^{-1} for mud and salt marsh and 0.06 μGy h^{-1} for other substrates. These data are compatible with those presented by McKay *et al.* (1995). However, where it is difficult to distinguish the result of a dose rate measurement from natural background, the method of calculating exposures based on the concentrations of man-made radionuclides in sediments (Hunt, 1984) has been used. Estimates of external exposures from beta radiation include a component due to natural sources because of the difficulty in distinguishing between natural and man-made contributions. Such estimates are therefore conservative when compared with the relevant dose limit which excludes natural sources of radiation.

7. BRITISH NUCLEAR FUELS PLC (BNFL)

BNFL is concerned mainly with the design and production of fuel for nuclear reactors and its reprocessing after irradiation. The company also operates a solid waste disposal site and nuclear power plant supplying electricity to the national grid. Regular monitoring is carried out of the environmental consequences of discharges of radioactive waste from four BNFL sites in England, namely Sellafield, Drigg, Springfields and Capenhurst.

7.1 Sellafield and Drigg, Cumbria

Operations and facilities at Sellafield include fuel element storage and decommissioning, the Magnox and oxide fuel reprocessing plants and the Calder Hall Magnox nuclear power station. Radioactive waste discharges include a very minor contribution from the adjoining UKAEA Windscale facilities. The most significant discharges are made from the BNFL fuel element storage ponds and the reprocessing plants, through which pass irradiated Magnox and oxide fuel from the UK nuclear power programme, and some fuel from abroad. Small discharges are made from the Drigg site whose main function is to receive solid radioactive wastes from Sellafield and other UK sites and to dispose of them in engineered trenches on land.

7.1.1 The aquatic monitoring programme

Liquid radioactive wastes from both Sellafield and Drigg are discharged under separate authorisations effectively to the same body of water on the Irish Sea coastline. The sites are therefore considered together for the purpose of aquatic environmental monitoring.

Discharges from the Sellafield pipelines during 1995 are summarised in Table 1. Discharges of tritium, carbon-14, cobalt-60 , technetium-99 and iodine-129 increased in 1995 because of the continuing treatment of stored wastes and the operation of the Thermal Oxide Reprocessing Plant (THORP). However, the discharges of radiocaesium were at the low levels typical of recent years and discharges of plutonium and americium reduced because of the operation of the Enhanced Actinide Removal Plant (EARP).

Total alpha and beta discharges were 0.397 and 188 TBq respectively (1994: 1.04 and 126 respectively). The increase in total beta discharges was mainly caused by beta emitters in releases of treated stored wastes. All discharges were within the limits set by HMIP and MAFF.

The main function of the Drigg site is to receive solid radioactive wastes from Sellafield and other UK sites and to dispose of them in engineered trenches on land. The authorisation for disposals allows for the discharge of leachate from the trenches through a 1 km marine pipeline. The limits for activity to be discharged through the marine pipeline and for concentrations of residual activity in the Drigg Stream are given in Table 1. These discharges are small compared with those discharged from the Sellafield site. MAFF marine monitoring of the Drigg site is subsumed within the Sellafield programme which is described in the remainder of this sub-section. The contribution to exposures due to Drigg discharges is negligible compared with that due to Sellafield and any effects of Drigg discharges could not be detected in 1995 above those due to Sellafield. Monitoring of the Drigg Stream is carried out by HMIP (HMIP, 1995).

Regular monitoring of the marine environment near Sellafield continued during 1995. Important radiation exposure pathways were consumption of fish and shellfish and external exposure to gamma rays and beta particles from occupancy over sediments, with other pathways being kept under review. In 1995, as in previous recent years, there was no harvesting of *Porphyra* in west Cumbria for manufacture of laverbread, but monitoring continued because the pathway remains potentially important. A general review of radioactivity in the Irish Sea has been compiled by Kershaw *et al.* (1992). In addition, Hunt (1995) has recently provided a reconstruction of exposures due to Sellafield liquid discharges from the beginning of operations in 1952 through to 1993.

7.1.1.1 The fish and shellfish consumption pathway

7.1.1.1.1 Concentrations of radioactivity

Concentrations of beta/gamma activity in fish from the vicinity of the Irish Sea and from further afield are given in Table 7. Data are listed by location of sampling or landing point, in approximate order of increasing distance from Sellafield. Samples taken near other nuclear establishments which reflect Sellafield discharges are given later in this report. The 'Sellafield Coastal Area' extends 15 km north and south of Sellafield from St Bees Head to Selker and 11 km offshore; most of the local fish and shellfish consumed by the local most exposed group is taken from this area. Specific surveys are carried out in the smaller 'Sellafield Offshore Area' where experience has shown that good catch rates may be obtained. This area consists of a rectangle, one nautical mile wide by two nautical miles long, situated south of the pipelines with the long side parallel to the shoreline; it averages about 5 km from the pipeline outlet.

The results generally reflect the progressive dilution of radiocaesium with increasing distance from Sellafield, but the rate of decline of radiocaesium concentrations with distance is not as marked as was the case some years ago, because of the significant reductions in discharges since that time. Radiocaesium in fish from the Baltic is not due to Sellafield discharges but is substantially from the Chernobyl accident. Concentrations of radiocaesium in fish known to have been caught in Icelandic waters remained typical of those from weapons-test fallout, at a value of about 0.3 Bq kg^{-1} for caesium-137 in cod. Data for the Barents Sea are similar. In the Irish Sea, the ratios of caesium-137 to caesium-134 were generally higher than those in recent discharges from Sellafield, even allowing for residence time in the water and uptake into fish; this suggests that a significant contribution from aged radiocaesium is present, due to remobilisation from the sediment of the Irish Sea (Hunt and Kershaw, 1990).

Concentrations of caesium-137 in rainbow trout from a small lake near Sellafield are included this year. The absence of any detected caesium-134 in the sample suggests that fallout from Chernobyl, which is detected in other freshwater fish in Cumbria, is unlikely to be the source of activity. The other possible sources are Sellafield itself and fallout from atmospheric weapon tests carried out by nuclear powers between 1945 and 1980.

There were small increases in concentrations of cobalt-60 and technetium-99 in fish from the eastern Irish Sea in 1995 reflecting changes in discharges from the site. However, the trend of reducing concentrations of radiocaesium in fish continued.

For shellfish, a wide range of radionuclides contribute to radiation exposure of consumers owing to generally greater uptake in these organisms than in fish. Table 8 lists concentrations of beta/gamma-emitting nuclides (except plutonium-241) and total beta activity in shellfish from the Irish Sea and further afield. Molluscs are of particular radiological importance to the most exposed group near to Sellafield, as described later in this section. In addition to sampling by MAFF, supplies of winkles, mussels and limpets were obtained from consumers who collected them in the Sellafield Coastal Area exploited by this most exposed group near to Sellafield.

Concentrations of artificial radionuclides in shellfish, as with fish, diminish with increasing distance from Sellafield. There are substantial variations between species: for example, lobsters tend to concentrate more technetium-99 when compared to crabs. In addition, molluscs tend to concentrate the less mobile nuclides to a greater extent than crustaceans, which in turn tend to concentrate them more than fish. The reverse behaviour has also been true for mobile nuclides in the past. However, since the importance of caesium-137 associated with sediment has increased relative to current discharges, concentrations of this nuclide in molluscs have tended to be higher than or similar to those for crustaceans. There were both increases and decreases of concentrations of beta/gamma-emitting radionuclides in shellfish in 1995. Increases occurred for carbon-14, cobalt-60 and technetium-99 and decreases for zirconium-95 and niobium-95. These changes reflect changes in discharges of these radionuclides but the magnitude of the change in discharge was not necessarily matched by an equivalent change in concentration. For example, the technetium-99 concentrations in some shellfish from west Cumbria have increased by more than a factor of 3 whereas the discharges have increased by a factor of 3. Such differences are caused by several factors including the timing of sampling and the rate at which biota respond to their environment reflecting the increases which took place in 1994.

Analyses for transuranics are labour-intensive; as in previous years, a selection of samples of fish and shellfish chosen mainly on the basis of potential radiological significance was analysed for transuranic nuclides. The data for 1995 are presented in Table 9. Transuranics are less mobile than radiocaesium in sea water; this is reflected in higher concentrations of transuranics in shellfish as compared to fish, and a rapid reduction with distance from Sellafield in concentrations of transuranics, particularly in shellfish. Over the past decade discharges of transuranic nuclides from Sellafield have reduced significantly, resulting in overall decreases in concentrations of these nuclides in fish and shellfish. However, the non-mobile nature of these nuclides causes a delayed effect in the environment (Hunt, 1985) such that a contribution to present concentrations is provided by discharges in earlier years. In 1995, concentrations of transuranic nuclides in fish and shellfish were generally similar when compared with 1994.

Concentrations of natural radionuclides in fish and shellfish in the Sellafield area are presented in Section 13.

7.1.1.1.2 Individual dose

Table 10 summarises doses in 1995 from artificial radionuclides in seafood. The committed effective dose to the local most exposed group of seafood consumers was 0.12 mSv. The increase in dose from 0.08 mSv reported for 1994 (Camplin, 1995) is largely due to the increase in consumption of molluscs by the most exposed group and the increased concentrations of technetium-99, particularly in crustaceans.

Data for natural radionuclides in fish and shellfish are discussed in Section 13; however, the effects on the Sellafield most exposed group of controlled discharges of natural radionuclides from another west Cumbrian source, Albright and Wilson Ltd, Whitehaven, are considered here to enable the total dose to be compared to the limit. The exposure of the local group of seafood consumers due to the enhancement of concentrations of natural radionuclides in the Sellafield area in 1995 was 0.22 mSv using a gut uptake factor for polonium of 0.8. Most of this was due to the polonium-210 and lead-210 content of shellfish. This gives a total dose to this group of 0.34 mSv. These doses may be compared with an average dose rate of approximately 2.2 mSv $year^{-1}$ to members of the UK public from all natural sources of radiation (Hughes and O'Riordan, 1993) and are well within the limit of 1 mSv.

Exposures of groups representative of the wider fishing communities associated with fisheries in Whitehaven, Dumfries and Galloway, Fleetwood and the Morecambe Bay area have been kept under review (Table 10). The doses received by these groups are significantly less than that for the local Sellafield group because of the lower concentrations observed further afield. The doses at Whitehaven, Dumfries and Galloway and Morecambe Bay were similar in 1995 to those in 1994 (0.03, 0.06 and 0.08 mSv respectively) (Camplin, 1995). Doses received by the Fleetwood group reduced to 0.031 mSv (1994: 0.05 mSv) because of changes to the consumption rates in the group as established by a recent habits survey. All doses were well within the dose limit for members of the public of 1 mSv.

The committed effective dose equivalent from artificial radionuclides, appropriate to a consumption rate of 15 kg $year^{-1}$ of fish from landings at Whitehaven and Fleetwood, is also given in Table 10. This consumption rate represents an average for typical fish-eating members of the public. The dose in 1995 was <0.002 mSv, the same as that for 1994 (Camplin, 1995).

The exposure of consumers of trout from a local fish farm were also considered in 1995. Their exposure, based on consumption rate data obtained by interview, was 0.046 mSv or 5% of the dose limit of 1 mSv. This includes a contribution due to fallout.

7.1.1.1.3 Collective dose

Collective doses, received during 1995 from consumption of fish and shellfish, have been estimated for the UK and other European countries. In general, the method used has been to combine data on actual fish and shellfish landings from relevant sea areas with average radioactivity concentrations in fish and shellfish caught in these areas. This method differs from that based on modelling of water movements and a (usually) fixed catch rate for different sea areas; the modelling method generally derives the collective dose to be received over a number of years as a result of discharges during the year under review, and the results are not readily comparable with those based on the present method. Sea areas considered in this assessment include the Irish Sea, Scottish waters, the North Sea, the English Channel, Baltic Sea, Norwegian Sea, Spitzbergen/Bear Island area and the Barents Sea. Corrections have been made for the fraction of fish or shellfish consumed. The contribution of weapons-test fallout to the radioactivity concentrations has been subtracted. Consideration has been given to the pathway due to fish offal and industrial fisheries, the product of both of which is fish meal which is fed to pigs, poultry, ruminants and farm-reared fish. Consumption of food products from these animals gives rise to a small contribution to the collective dose, and this has been included.

Liquid radioactive waste discharges from Sellafield are the main source of collective dose; by comparison, the effect of liquid discharges from other establishments is very small. The small contribution due to fallout from the Chernobyl reactor accident to the Irish Sea, Scottish waters and the North Sea has been included. Most of the collective dose is due to radiocaesium in edible fish; however, approximately one quarter of the total dose is due to plutonium and americium radionuclides in shellfish. Strontium-90 also makes a small contribution to the collective dose, about 5% of the total. The results for 1995, of 3 man-Sv for the UK and 20 man-Sv for other European countries are similar to those reported for 1994.

The collective dose to the UK population due to the effects of liquid discharges may be compared to that from other sources. In Hughes and O'Riordan, 1993 the collective dose to the UK population from all sources of natural background radiation is given as 127,000 man-Sv and that from all source of artificial radiation as 23,000 man-Sv. Therefore the UK collective dose delivered in 1995 through the seafoods pathway as a result of liquid radioactive waste discharges was less than 0.01 % of the total from all sources of radiation.

7.1.1.2 External exposure

A further important pathway leading to radiation exposure as a result of Sellafield discharges derives from uptake of gamma-emitting radionuclides by intertidal sediments in areas frequented by the public. In general, it is the fine-grained muds and silts prevalent in estuaries and harbours, rather than the coarser-grained sands to be found on open beaches, which adsorb the radioactivity more readily. Gamma dose rates currently observed in intertidal areas are mainly due to radiocaesium and natural radionuclides.

A range of coastal locations are regularly monitored, both in the Sellafield vicinity and further afield, using portable gamma-radiation dosemeters. Table 11 lists the locations monitored together with the dose rates in air at 1 m above ground. Monitoring in Scotland is carried out on behalf of the Scottish Office. Dose rates on Irish Sea shorelines, near other nuclear establishments which reflect Sellafield discharges, are given later in this report. Variations in sediment type from place to place account for the quite marked fluctuations in dose rate, superimposed on a general decrease with increasing distance from Sellafield. Dose rates over intertidal areas throughout the Irish Sea in 1995 showed small reductions as compared with data for the same locations in 1994 (Camplin, 1995). Data for the River Calder continued to show an excess above natural background and it is likely that the main cause is direct radiation from Calder Hall. However, there may also be a contribution due to radionuclides in small patches of sediments in the river. The occupancy by members of the public, for example anglers, of this section of the river is low. It is unlikely that more than a few tens of hours per year is spent near the sediment patches and, on this basis, the resulting exposures were much less than those of intertidal areas discussed subsequently in this sub-section.

Radioactivity concentrations in surface sediments are also regularly monitored, both because of relevance to dose rates and in order to keep under review distributions of adsorbed radioactivity. Concentrations of beta/gamma radioactivity and transuranics, in most cases at the same locations as the dose rate measurements, are given in Table 12. Variations due to similar causes to those of the variation in dose rates are observed, and comparison with results for 1994 (Camplin, 1995) shows small general reductions of radioactivity. Data for small patches of sediment in the River Calder are also included in Table 12. Cobalt-60 is present in these samples and this may be due to deposition of authorised discharges to air from Calder Hall.

In western Cumbria the maximum exposure in 1995 was 0.13 mSv for anglers who dig for bait near to Sellafield and who fish in the Cumbrian Coastal Area. Their dose, which was similar to that for 1994 (0.11 mSv) includes an assessment of the contribution to effective dose from beta emitting radionuclides in sediments and due to consumption of locally caught fish. Dose rates on, and occupancy of, fishing vessels in Whitehaven harbour reduced in 1995 so that the dose received by fishermen reduced from 0.10 mSv in 1994 (Camplin, 1995) to

0.060 mSv in 1995. Both estimates include a small contribution due to consumption of seafood. In the wider area, including Cumbria, Lancashire and the north Solway coast it is considered that houseboat dwellers in the Ribble estuary are representative of those who receive the highest external exposures from the effects of discharges from Sellafield. Making an allowance for natural background using a dose rate of 0.07 μGy h^{-1} their external exposure in 1995 was 0.091 mSv, which is less than the value for 1994 of 0.14 mSv calculated on the same basis. The reduction was due to a decrease in occupancies and gamma dose rates on the boat. Most of the external exposure of the houseboat dwellers was due to the radioactivity already in the environment as a result of past discharges from Sellafield.

It is to be noted that inhalation of resuspended beach sediments and inadvertent ingestion of the same material give rise to only minor radiation exposures to the public compared with the external radiation pathway considered in this sub-section (Wilkins *et al.,* 1994). In areas of salt marsh and sea-washed pastures such as the Ravenglass estuary exposures from pathways other than those due to external radiation need consideration, and this is currently being given from the point of view of regular monitoring needs. Meanwhile, doses including external radiation in such areas were cautiously assessed for 1989 to be well within the dose limit of 1 mSv (Wilkins *et al.,* 1994). This would also have been the case in 1995 because relevant concentrations of activity and dose rates in such areas have reduced since 1989. Monitoring in the Ravenglass estuary is considered further in sub-section 7.1.2.

7.1.1.3 Fishing gear

During immersion in sea water, fishing gear may entrain particles of sediment on which radioactivity is adsorbed. Fishermen handling this gear may be exposed to external radiation, mainly to skin from beta particles. Fishing gear is regularly monitored using portable beta dosimeters. Results for 1995 are presented in Table 13. Measured dose rates were generally less than those for 1994 (Camplin, 1995). Habits surveys keep under review the amounts of time spent by fishermen handling their gear; for those most exposed, a time handling nets and pots of 2500 h $year^{-1}$ was appropriate for 1995. The exposure from handling of fishing gear in 1995, including a component due to natural radiation, was 0.30 mSv, which is less than 1% of the dose limit appropriate for exposures to skin of members of the public. Handling of fishing gear therefore continues to be a minor radiation exposure pathway.

7.1.1.4 Contact dose-rate monitoring of intertidal areas

Contact beta and gamma dose rates in intertidal areas are regularly monitored using purpose built large area detectors to locate and remove any material with unusual levels of contamination. A single item was found in June 1995 with a contact dose rate of less than 0.1 mGy h^{-1}. A routine programme of measurements of beta dose rates on contact with shoreline sediments was begun in 1994 in order to establish the contribution to effective dose made by exposures of people, such as bait diggers, who handle sediments regularly, and to estimate their skin exposures for comparison with the non-stochastic dose limit of 50 mSv. The results of the measurements made using portable beta dosimeters are presented in Table 15.

The skin exposure of anglers who dig bait, based on a time handling sediment of 600 h $year^{-1}$, was 0.84 mSv in 1995 which is 2% of the appropriate dose limit. The contribution this source of exposure makes to effective dose is included in the assessment in sub-section 7.1.1.2.

7.1.1.5 Other surveys

In addition to the monitoring described above, which is related to the most (or potentially most) significant radiation exposure pathways as a consequence of Sellafield discharges, a number of further investigations are undertaken. Some of these are of a research nature; however, they also enable pathways of lower current importance to be kept under review.

Seaweeds are useful indicator materials; they may concentrate certain radionuclides, so they greatly facilitate measurement and assist in the tracing of these radionuclides in the environment. Table 14 presents the results of measurements in 1995 on marine plants from shorelines of the Irish Sea and further afield. Although small quantities of samphire and *Rhodymenia* may be eaten, concentrations of radioactivity were of negligible radiological significance. *Fucus* seaweeds are useful indicators, particularly of fission product radionuclides other than ruthenium-106; samples of *Fucus vesiculosus* were collected both in the Sellafield vicinity and further afield, and the results are presented here. These clearly showed the effects of increases in discharges of technetium-99 from Sellafield in 1995. Such seaweeds are occasionally used as fertilisers and soil conditioners. However, the exposures from consumption of crops grown on land to which seaweed has been applied would have been very low. Monitoring of concentrations of radionuclides in seaweeds in Scotland is carried out on behalf of the Scottish Office. Analyses of similar samples collected in Northern Ireland are carried out on behalf of the DOE(NI).

No harvesting of Porphyra in west Cumbria, for consumption after being made into laverbread, was reported in 1995; this pathway has therefore remained essentially dormant. However, monitoring has continued in view of its potential importance, historical significance and the value of Porphyra as an indicator material. Samples of Porphyra are regularly collected from selected locations along UK shorelines of the Irish Sea. Results of analyses for 1995 are presented in Table 14. Samples of laverbread from the major manufacturers are regularly collected from markets in South Wales and analysed. Results for 1995 are also presented in Table 14. The exposure of critical laverbread consumers in South Wales was much less than 0.005 mSv, confirming the virtual abeyance of this exposure pathway.

7.1.2 The terrestrial monitoring programme

Because of the proximity of the sites, environmental monitoring at Sellafield and Drigg are considered together in this sub-section. In addition, the programme around the Ravenglass estuary approximately 10 km south of the Sellafield is included. The purpose of that programme is to investigate contamination of sea-washed land resulting from disposals of liquid waste from Sellafield.

7.1.2.1 Sellafield

Discharges of gaseous wastes from Sellafield are summarised in Table 2. They were generally similar to those in 1994, however, the operation of the THORP plant increased discharges of krypton-85 from 38 PBq in 1994 to 97 PBq in 1995. This radionuclide is chemically inert and therefore has no effect on the exposures due to consumption of terrestrial foods. Atmospheric discharges of carbon-14 were reduced, as compared with 1994, due to diversion of this nuclide to the liquid discharge pathway.

The sampling programme for terrestrial foods in the vicinity of Sellafield was the most extensive of those for the nuclear sites in England and Wales in order to reflect the scale of the operations on the site. A wide range of foodstuffs were sampled including milk, fruit, vegetables, eggs, meat and offal, mushrooms, game, honey, cereals and indicator materials such as grass and soil. Samples were obtained from different locations around the site in order to encompass the possible variations in activity levels due to the influence of wind direction on the dispersal of gaseous discharges. The analyses undertaken included gamma spectrometry and specific measurements for tritium, carbon-14, sulphur-35, strontium-90, technetium-99, iodine-129, radiocaesium, polonium-210, uranium and transuranics. The polonium-210 analyses were carried out to give an indication of any historic contamination from past discharges and also to confirm that there is no continuing source of this nuclide at Sellafield.

The results of monitoring in 1995 are presented in Table 16. The concentrations of all radionuclides were low and there was no indication of widespread contamination from the site. However, small enhancements of some radionuclides were found close to the site.

The ratio of the mean concentration in milk collected from near and far farms was close to 1 for all radionuclides except sulphur-35 when it was 2. Stronger evidence was found for a site related effect by examination of the maximum concentrations at single farms. In this case, ratios greater than 1 were also found for carbon-14 (2), strontium-90 (2) and caesium (2). As will be shown later, taken together it is those radionuclides in milk which make the greatest contribution to exposures of consumers of local produced food. Concentrations in milk were similar to those in 1994 (MAFF, 1995) with the exception of those for sulphur-35 where small increases were observed. This increase is probably a consequence of the enhanced levels of sulphur-35 discharged from the Calder Hall reactors during May 1995.

Enhanced discharges of iodine-129 took place during August 1995. No impact on the food chain or the environment could be detected as a consequence of this increase, although the highest levels of iodine-129 in crops detected was in runner beans harvested about this time.

Samples of apples, blackberries and elderberries were analysed in 1995. All three fruits were good indicators of the local effects of discharges from Sellafield. Plutonium concentrations, whilst much lower than those found in seafood, gave isotopic ratios ((239+240)/238) significantly less than 10. With a ratio of about 40 expected for background fallout, these data demonstrate a local source. Concentrations of carbon-14 in fruit samples was also in excess of the concentrations assumed as representative of background values (Appendix 5). Concentrations of other radionuclides, for example tritium, sulphur-35 and cobalt-60 and strontium-90 also provided evidence of a local effect. Where it was possible to compare data for fruit in 1995 with those for 1994, similar or increased concentrations of activity were found. However, in view of the limited number of samples obtained, no conclusion can be drawn as to whether there is a significant trend in levels of any particular radionuclide.

Levels of activity in bovine and ovine meat and offal continued to be analysed in 1995. Concentrations of radionuclides were low, with limited evidence for the effects of Sellafield discharges in data for tritium, carbon-14, sulphur-35 and the plutonium isotopic ratio.

Both barley and oats were sampled as being representative of cereals in 1995. Sulphur-35 was detected in both samples, indeed cereals contained the highest levels of this radionuclide when compared with other food groups. In common with meat and offal samples limited evidence for the effects of Sellafield discharges was also found in data for tritium, carbon-14, sulphur-35 and the plutonium isotopic ratio. The vegetables sampled in 1995 were cabbage, carrots, lettuce, peas, potatoes, runner beans, spinach and turnips. Concentrations of transuranic radionuclides in vegetables were very low and did not provide as distinct a Sellafield signal in the plutonium isotopic ratio as some other food groups. Evidence of the effects of Sellafield was also weak for other radionuclides in vegetables with two possible exceptions. Carrots and runner beans contained some of the highest concentrations of strontium-90 (5.6 Bq kg^{-1}) and iodine-129 (0.14 Bq kg^{-1}) in all of the terrestrial foods sampled.

Finally, the most distinctive features of the data for eggs, game, mushrooms and honey were:

- Eggs contained the highest iodine-129 concentration in all terrestrial foods from Sellafield (0.20 Bq kg^{-1})
- Eggs contained the second highest tritium concentration in terrestrial foods from Sellafield (34 Bq kg^{-1})
- Hare and rabbit contained relatively high levels of caesium (~5 Bq kg^{-1})

The dose received by the most exposed group of terrestrial food consumers was calculated using the methods and data presented in Section 6. The results are presented in Table 17. Calculations were performed for three age groups (adults, 10y and 1y) and the doses received by the 1 year old age group were found to be the highest, at <0.081 mSv (Adult: <0.042; 10y: <0.047). The most significant contributions to this dose were from sulphur-35, strontium-90 and carbon-14. The most important foodstuff is milk which accounts for 70% of the dose. The exposure is an upper estimate of the effects of Sellafield discharges because: (i) it is based on the assumption that a radionuclide which is not detected in a sample is present at a concentration equivalent to the limit of detection; (ii) the effects of the background of artificial nuclides in the area from fallout are included; and (iii) it is assumed that most food consumed is locally produced.

The exposure of the group increased in 1995 (1994: <0.051 mSv) because of two main factors. Firstly, an increase in the dose coefficient for strontium-90 used in the calculations was required by the need to account for the ingrowth of its daughter product, yttrium-90 in the period between the strontium-90 being incorporated in the foodstuff and consumption. It is recognised that in case of milk that the period between incorporation of the strontium-90 in the milk and consumption is short and equilibrium may not have been reached. However, consumption data for milk includes milk products such as cheese and butter in which equilibrium will be reached. thus this conservative assumption is justified . Secondly, the maximum observed concentration of sulphur-35 in milk increased from 3 to 9 Bq kg^{-1}. Despite this, the exposure of the most exposed group was less than 10% of the dose limit of 1 mSv.

The dose received by an average consumer obtaining food from the vicinity of Sellafield, <0.023 mSv, was much less than this.

7.1.2.2 Ravenglass

The main interest in monitoring of terrestrial foodstuffs in the Ravenglass area is in determining whether there is a significant transfer of radionuclides from sea to land. In order to establish this samples of milk, crops, fruit and livestock are collected and analysed for radionuclides which are released in liquid effluent discharges from Sellafield. In addition analyses for sulphur-35 are also undertaken for comparison with results for the immediate area around Sellafield.

The results of measurements in 1995 are presented in Table 18. Modelling was also carried out to supplement the monitoring data. Details of this monitoring are given in Appendix 6. In general, the data are similar to those for 1994 (MAFF, 1995) and show lower concentrations than are found in the Sellafield vicinity. Evidence for sea to land transfer is limited. The clearest indication is given by the results for mushrooms. Concentrations of plutonium in mushrooms demonstrate an isotopic ratio which is more characteristic of liquid effluent discharges than fallout; in addition values for plutonium-239+240 and americium-241 at about 1 Bq kg^{-1} (wet weight) are more than an order of magnitude higher than those near Sellafield. The exposure due to consumption of the Ravenglass mushrooms was <0.008 mSv. The radiological significance of this observation is therefore small.

No evidence for the transfer of technetium-99 to terrestrial foodstuffs was found. All results were below the limits of detection. However, concentrations of caesium in ovine samples were about a factor of two higher than in samples from Sellafield. This may be due to sea to land transfer but it could equally be due to the natural variability in levels of Chernobyl or weapon test fallout in west Cumbria. The only other strong indication of the effects of Sellafield is found in barley where a low concentration of sulphur-35 was detected. This would have been due to gaseous discharges from the site.

The exposure due to consumption of terrestrial foods from Ravenglass in 1995 is given in Table 17. The 1 year old age group received the highest exposures. Their exposure, including contributions from Chernobyl or weapon test fallout, was less than 0.037 mSv or 4% of the dose limit of 1 mSv. This is about half the value for the same age group near Sellafield. From this evidence, sea to land transfer in this area is not having a major effect on the terrestrial food chain.

7.1.2.3 Drigg

No gaseous discharges are authorised from Drigg. The monitoring programme is therefore primarily directed at the potential migration of radionuclides from the waste burial site via ground water. The results are given in Table 19.

Low concentrations of tritium which may have leached from the site were found in blackberries and mushrooms, however they were of negligible radiological significance. Other than this there was no evidence to suggest migration of activity from the site was taking place. In general concentrations of other radionuclides detected were lower than those found near Sellafield. The radiation exposure of the most exposed group, including a component due to Chernobyl or weapon test fallout was less than 0.035 mSv or 4% of the dose limit of 1 mSv.

7.2 Springfields, Lancashire

This establishment is mainly concerned with the manufacture of fuel elements for nuclear reactors and the production of uranium hexafluoride. Radioactive liquid waste arisings consist mainly of thorium and uranium and their decay products; liquid discharges are made by pipeline to the Ribble estuary. Discharges of beta radionuclides, which result in the greater radiological impact, were similar in 1995 (112 TBq) as compared with 1994 (114 TBq) and remained well within authorised limits. Discharges of gaseous effluents remained very low at a similar level to those for 1994. The authorisation was changed in 1995 to specify a limit for uranium activity.

Public radiation exposure in this vicinity, as a result of site discharges, is relatively low; there is, however, a greater contribution in the estuary due to Sellafield discharges. The most important marine pathway is external exposure, due to adsorption of radioactivity on the muddy areas of river banks and in salt marshes. The most exposed group consists of people who live on a houseboat moored in a muddy creek of the Ribble estuary. Other activities which have significant occupancies are wildfowling which takes place in intertidal areas and marshes bordering the estuary and angling which is popular in the Preston area (Hunt, 1992). A survey of recreational pathways was carried out by Mudge *et al.* (1994). Gamma and beta dose rates are regularly monitored in relevant areas including muddy creeks where houseboats are moored, and some of these measurements are supported by analyses of sediments. In 1995, locally-obtained fish and shellfish continued to be sampled though consumption of seafood from the estuary is considered to be low. A study (Rollo *et al.,* 1994) has shown that exposures due to airborne radionuclides which may have come from discharges to the estuary are negligible.

Monitoring of terrestrial foods included sampling of milk, fruit, vegetables and duck. Indicator materials including dry cloths, grass, soil and animals faeces were also sampled.

Results for 1995 are shown in Tables 20(a) and (b). Radionuclides detected which were partly or wholly due to Springfields discharges were isotopes of thorium, uranium and their decay products. Natural sources also contributed to these activities. Other radionuclides present were mainly from Sellafield.

Gamma dose rates over intertidal areas in 1995 were similar to or less than those in 1994. The results of beta dose rate measurements are variable with increases and decreases observed in different parts of the estuary. In 1995 the exposure of the most exposed group of houseboat dwellers including the Sellafield component was 0.091 mSv, a decrease from the value for 1994 (0.14 mSv) because of a reduction in occupancies and dose rates on the boat. Most of this exposure was due to the radioactivity already in the environment as a result of past discharges from Sellafield. The whole-body exposure of anglers and wildfowlers were assessed as being 0.042 and 0.029 mSv respectively in 1995. A significant proportion of the dose is due to Springfields discharges.

The most exposed group for skin irradiation was anglers with skin exposures, including a component due to natural radiation, of 2.6 mSv in 1995. This is 5% of the relevant dose limit for members of the public.

The most exposed group of terrestrial food consumers were adults consuming vegetables and potatoes at high rates. Their dose in 1995, including a contribution due to fallout and natural sources, was <0.006 mSv, a major part of which was due to thorium radionuclides.

7.3 Capenhurst, Cheshire

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO Capenhurst Ltd. Radioactive waste arisings, mainly of uranium and its daughter products, and technetium-99 and neptunium-237 from recycled fuel, are minor; in 1995 BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook and to the North Wirral sewage outfall at Meols. The authorisation for the latter pathway was revoked in late 1995. An environmental monitoring programme is carried out related to the pathways which could be of radiological significance due to all disposal routes. Plants, animal faeces, soil and dry cloths are also sampled as indicator materials.

Results for 1995 are presented in Table 21. Concentrations of radionuclides in materials from the land and from the Rivacre Brook were similar to those for 1994. The hypothetical most exposed group for liquid discharges from the site is considered to be people who may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates, the exposure of the group was very low, at less than 0.005 mSv in 1995. The concentrations of artificial radioactivity in marine samples are consistent with values expected at this distance from Sellafield. The exposure of the most exposed group of terrestrial food consumers was also very low, at less than 0.005 mSv in 1995.

8. UNITED KINGDOM ATOMIC ENERGY AUTHORITY

The United Kingdom Atomic Energy Authority (UKAEA) operates in England at Harwell, Winfrith and Windscale, adjacent to the BNFL Sellafield site. All three sites have reactors that are currently being decommissioned. Discharges of radioactive waste are related to decommissioning and decontamination operations and the nuclear related research that is undertaken at all sites. Discharges from the Windscale site are negligible compared to Sellafield. Regular monitoring of the environment in relation to Harwell and Winfrith is undertaken and discharges from Windscale are monitored by the Sellafield programme.

8.1 Harwell, Oxfordshire

Discharges of radioactive wastes from Harwell continued in 1995 with liquid discharges made under authorisation to the River Thames at Sutton Courtenay and to the Lydebank Brook north of the site while gaseous discharges were made to the atmosphere. Discharges of alpha and beta particulates to the atmosphere were reduced, as compared to previous years, due to the installation of new extract plants on the DIDO and Pluto reactors. The monitoring programme comprised of sampling of milk, other terrestrial foodstuffs, freshwater fish and indicator materials together with measurements of gamma dose rates around the liquid discharge points.

The results of measurements of radioactivity concentrations and dose rates are shown in Tables 22(a) and (b). Tritium was detected in apples, elderberries and rhubarb collected near the site at low levels similar to those observed in local foodstuffs in previous years. The exposure of the most exposed group of terrestrial food consumers was estimated to be less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

Some nuclides, notably cobalt-60 and caesium-137, were enhanced close to the outfall for liquid wastes, but the levels were very small in terms of any radiological effect. Those found in Lydebank Brook were lower still.

Habits surveys have identified anglers as the most exposed group affected by direct discharges into the river. Their occupancy of the river bank has been assessed to estimate their external exposures. Consumption of freshwater fish was not found, but it is considered prudent to include a component in the assessment of the angler's exposure equivalent to a hypothetical consumption of fish at a rate of 1 kg $year^{-1}$. On this basis, and excluding a background dose rate of 0.06 µGy h^{-1}, the radiation dose to anglers in 1995 was 0.017 mSv, or less than 2% of the dose limit of 1 mSv.

8.2 Winfrith, Dorset

Discharges of radioactive wastes from this site continued in 1995 at the low rates typical of recent years following the shutdown of the Steam Generating Heavy Water Reactor (SGHWR) in September 1990. Liquid wastes are disposed of under authorisation to deep water in Weymouth Bay. The monitoring programme comprised sampling of milk, crops, fruit, seafood and indicator materials and measurements of gamma dose rates on the foreshore. Data are presented in Tables 23(a) and (b).

Increased levels of ventilation in the Gaseous Tritium Light Device facility resulted in increased levels of tritium discharge until the operations in the facility were ceased.

Results for terrestrial samples gave no indication of an effect due to gaseous discharges. Levels of carbon-14 detected were typical of the background concentrations to be expected. The most exposed group for gaseous discharges comprised the 1 year old age group who were estimated to receive an exposure of less than 0.005 mSv or 0.5% of the dose limit of 1 mSv. Concentrations of radionuclides in the marine environment continued their decline in 1995 as compared with previous years; this was due to the lower level of discharges from the site since the closure of the SGHWR. The radiation dose to the most exposed group of fish and shellfish consumers remained low in 1995 at less than 0.005 mSv or 0.5% of the dose limit.

9. NUCLEAR POWER STATIONS OPERATED BY NUCLEAR ELECTRIC PLC [d]

In 1995 Nuclear Electric were authorised to dispose of wastes from 11 establishments in England and Wales. All were operational power stations with the exception of Berkeley and Trawsfynydd power stations which were undergoing decommissioning, and Berkeley Technology Centre which provided research facilities for the Company.

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[d] *On 31 March 1996 the Nuclear Power stations operated by Nuclear Electric PLC were transferred to two new companies, Nuclear Electric Ltd and Magnox Electric PLC. During the period covered by this report these stations were operated by Nuclear Electric PLC and this company is referred to throughout the report.*

9.1 Berkeley, Gloucestershire and Oldbury, Avon

Berkeley Power Station ceased electricity generation in March 1989, but small amounts of radioactive wastes still needed to be disposed of as part of decommissioning operations. In addition there is a component of the discharge from the adjoining Berkeley Technology Centre. The Oldbury Power Station has continued operation and because the effects of both sites are on the same area, Berkeley and Oldbury are considered together for the purposes of environmental monitoring. Liquid radioactive wastes are discharged to the Severn estuary.

Habits surveys have established that the two critical pathways for public radiation exposure in the aquatic environment are internal radiation following consumption of locally-caught fish and shellfish, and external exposure from occupancy of muddy intertidal areas. Therefore, samples of fish and shellfish are analysed and gamma dose rates are monitored. In addition, measurements of external exposure are supported by analyses of intertidal mud, and *Fucus vesiculosus* is collected as an indicator material. The focus for terrestrial sampling remained on the tritium, carbon-14 and sulphur-35 content of milk, crops and fruit, supported by analysis of dry cloths.

Data for 1995 are presented in Tables 24(a) and (b). Gamma dose rates and concentrations in the aquatic environment were similar to those in recent years. Most of the artificial radioactivity detected was due to carbon-14 and radiocaesium. Concentrations of radiocaesium represent the combined effect of discharges from the sites, other nuclear establishments discharging into the Bristol Channel, fallout, and possibly a small Sellafield-derived component. Most of the carbon-14 is due to discharges from Cardiff. Very small concentrations of other radionuclides were detected but taken together, were of low radiological significance. The total exposure of the most exposed group of fish and shellfish consumers including external radiation was low, at 0.010 mSv or 1% of the dose limit of 1 mSv.

An unplanned reactor blowdown at Oldbury in the last quarter of the year led to the Quarterly Notification Level for argon-41 being exceeded. This nuclide is chemically inert and therefore does not have an impact on the foodchain. Disconnection of the thermal shield air cooling stacks as part of the decommissioning at Berkeley has led to a reduction in the discharges to the atmosphere. Tritium and sulphur-35 were not detected in any of the terrestrial food samples monitored. Carbon-14 was detected in local milk and crops at levels generally consistent with background values, though data for blackberries and runner beans suggest that there may be a small enhancement above background for these food groups. Nevertheless, the most exposed group dose continued to be low and was estimated to be less than 0.005 mSv or 0.5% of the dose limit.

9.2 Bradwell, Essex

This power station, powered by Magnox reactors, is authorised to discharge gaseous wastes to the local environment and liquid wastes to the estuary of the River Blackwater. Terrestrial sampling is similar to that for other power stations including analyses of milk and crop samples for tritium, carbon-14 and sulphur-35. Aquatic sampling was directed at external exposure of people who live on houseboats in muddy areas of the estuary and consumption of locally-caught fish and shellfish. It included the commercial oyster fishery of importance in the northern part of the estuary. Gamma dose rate measurements are supported by analyses of intertidal sediment, and *Fucus vesiculosus* is analysed as an indicator material.

Measurements for 1995 are summarised in Tables 25(a) and (b). Gamma dose rates confirmed the importance of direct radiation from the reactors in the immediate vicinity of the site. Further afield, dose rates could not be distinguished from the natural background. Low concentrations of artificial radioactivity were detected in aquatic materials due to the combined effects of discharges from the station, Sellafield discharges, and fallout. Apportionment of the effects of these sources is difficult because of the low levels detected; concentrations were similar to those for 1994 (Camplin, 1995). A calculation based on concentrations of radionuclides in sediments has been used to estimate the external exposure of the houseboat dwellers who were the most exposed group in 1995. Their exposure including the effects of consumption pathways, was small, amounting to 0.011 mSv or 1% of the dose limit of 1 mSv.

Concentrations of activity were also low in terrestrial samples. There was nevertheless an indication in local fruit that carbon-14 levels had been enhanced by the operation of the power station. Despite this, the most exposed group exposure was estimated to be less than 0.005 mSv or 0.5% of the dose limit of 1 mSv, confirming that the radiological impact of authorised discharges from Bradwell was very low.

9.3 Dungeness, Kent

There are two, essentially separate, 'A' and 'B' nuclear power stations on this site; the 'A' station is powered by Magnox reactors and the 'B' station by advanced gas-cooled reactors (AGRs). Discharges are made via separate, but adjacent, outfalls and stacks and for the purposes of environmental monitoring are considered together.

Analyses for tritium, carbon-14 and sulphur-35 in terrestrial samples, were supplemented by a small number of analyses for strontium-90, iodine-131 and caesium-137 taken primarily for comparison with Sellafield samples. Marine monitoring included gamma and beta dose rate measurements on beaches and analysis of seafood and indicator materials. The results for 1995 are given in Tables 26(a) and (b).

Concentrations of radiocaesium in marine materials are attributable to discharges from the stations and to weapons test's fallout with a contribution due to discharges from Sellafield. Apportionment is difficult at these low levels. Trace levels of cobalt-60 in some marine materials are likely to be due to the combined effects of discharges from the site and from other sites on the English Channel coast. The small concentrations of transuranics in whelks and mud were typical of levels expected at other sites remote from Sellafield. The most exposed group in 1995 continued to be represented by local bait diggers who also eat fish and shellfish. Gamma dose rates over intertidal sediments, measured using portable instruments, were difficult to distinguish from the natural background, thus the external exposure of the most exposed group has been based on a calculation using concentrations of radionuclides in sediment. The radiation exposure of the aquatic most exposed group was low, at less than 0.008 mSv or 0.8% of the dose limit of 1 mSv.

Activity concentrations in most terrestrial foods were less than the limits of detection. Levels of carbon-14 discharged from the 'A' station were increased, as compared to 1994, but levels were generally within the range of activity concentrations observed for background sources with the exception of blackberries where a small enhancement was observed. Low concentrations of sulphur-35 and caesium-137 were detected in sea kale; the former is likely to be due to station discharges, and the latter to marine sources. The maximum exposure due to gaseous discharges was received by the 1 year old age group. Their exposure in 1995 was estimated to be less than 0.013 mSv or 1% of the dose limit.

9.4 Hartlepool, Cleveland

This station is powered by twin AGRs. The authorisations were revised in 1995 to set lower limits on discharges and to be more prescriptive in terms of the types of radioactivity specified in the authorisations (see Tables 1 and 2). The critical pathway for radiation exposure due to liquid effluent discharges is internal irradiation following consumption of local fish and shellfish. Collection of small coal, which is washed ashore along this stretch of coast, is used to represent the highest beach occupancies. The sampling and measurement programmes at Hartlepool were similar to those for other power station sites. However technetium analysis in *Fucus vesiculosus* is used as a specific indication of the far-field effects of discharges to sea from Sellafield.

Results of the monitoring programme carried out in 1995 are shown in Tables 27(a) and (b). The effects of gaseous discharges from the site were not clearly detectable in foodstuffs, though a slight enhancements of carbon-14 levels in sloes cannot be ruled out. The most exposed group exposure in 1995 was less than 0.009 mSv or 0.9% of the dose limit of 1 mSv.

The only detectable effect of liquid effluent discharges from the power station was observed in an increased level of tritium in seawater (16 Bq l^{-1}). Discharges of tritium from the power station are discontinuous and levels in the environment vary accordingly. Camplin *et al* (1990) has observed concentrations in excess of 100000 Bq l^{-1} immediately after a discharge. Even at this level the radiological significance of the discharges was minor because of the very low radiotoxicity of the nuclide. An increase in the level of technetium-99 in *Fucus vesiculosus* was also observed in 1995 (30 Bq kg^{-1}: 1995; 9.0 Bq kg^{-1}: 1994). This is due to increased discharges of this radionuclide from BNFL Sellafield. Low-levels of iodine-131 detected were likely to be from local hospitals. Concentrations of radiocaesium and transuranics were mainly due to discharges from Sellafield and to weapons tests' fallout. Gamma and beta dose rates were difficult to distinguish from natural background with the exception of measurements at Paddy's Hole. In this location, waste slag from a steel works can be found containing enhanced levels of gamma emitting natural radionuclides. The radiation exposure of the most exposed group of local fish and shellfish consumers was low, at less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

9.5 Heysham, Lancashire

This establishment comprises two, essentially separate, nuclear power stations both powered by AGRs. Discharges of radioactive waste from both stations are made under authorisation via adjacent outfalls in Morecambe Bay and stacks and for the purposes of environmental monitoring are considered together. Revisions to the authorisations in 1995 set lower limits for the majority of the radionuclides discharged and were more prescriptive in terms of the types of radioactivity specified. The monitoring programme for the effects of gaseous discharges was similar to that for other power stations. That for liquid discharges was also similar, including sampling of fish, shellfish and indicator materials and measurements of gamma dose rates, but for completeness the data considered in this sub-section includes all of that for Morecambe Bay. Parts of the programme are therefore in place in order to monitor the effects of Sellafield. Samphire is also collected and analysed because of its use as a foodstuff.

The results for 1995 are given in Tables 28(a) and (b). Concentrations of carbon-14 and technetium-99 increased in marine materials due to discharges from Sellafield. Otherwise similar levels to those for 1994 (Camplin, 1995) were observed and the effect of liquid discharges from Heysham was not detectable above the

Sellafield observed background. The radiation exposure in 1995 to the most exposed group of fishermen including a component due to external radiation was 0.073 mSv which is well within the dose limit of 1 mSv. This represents a small decrease from the estimate for 1994 of 0.08 mSv (Camplin, 1995). Most of this exposure was due to the effects of discharges from Sellafield though the increased levels of carbon-14 and technetium-99 noted above made only a small contribution to the assessed dose. Concentrations of radioactivity in samphire were of negligible radiological significance.

The effects of gaseous discharges were also not detectable in 1995. All observations were less than the limits of detection with the exception of activity concentrations of carbon-14 which were consistent with the range of background values to be expected. The most exposed group dose was estimated to be less than 0.012 mSv or 1% of the dose limit of 1 mSv.

9.6 Hinkley Point, Somerset

At this establishment there are two, essentially separate, 'A' and 'B' nuclear power stations; the 'A' station is powered by Magnox reactors and the 'B' station by AGRs. Environmental monitoring considers the effects of the two power stations together. Small changes were made to the authorisation to dispose of liquid waste to the Bristol Channel in 1995 to reflect changing operations on the 'B' site. Analyses of milk and crops were undertaken to measure activity concentrations of tritium, carbon-14, sulphur-35 and gamma emitters. Analyses of seafood and marine indicators materials and measurements of external radiation over muddy intertidal areas were also carried out.

The results for 1995, presented in Tables 29 (a) and (b) indicate a small effect due to discharges of gaseous wastes. Activity concentrations of tritium and gamma emitters in terrestrial materials were all below the limits of detection. Concentrations of sulphur-35 in fodder beet were lower than those in 1994 (MAFF, 1995) whilst those of carbon-14 were similar. Some of the concentrations of carbon-14 in fruit and crops were higher than the default values used to represent background levels (Appendix 5), but given the expected range of background carbon-14 concentrations within a food group, the evidence is inconclusive as to the potential of a local source. The estimated most exposed group from radioactivity in the terrestrial environment exposure was less than 0.013 mSv or 1% of the dose limit of 1 mSv.

The concentrations observed in the Bristol Channel were generally similar to those in 1994, but there were small increases in manganese-54, cobalt-60, zinc-65 and cerium-144 which may have reflected increases in discharges from the 'A' station. The concentration of tritium in seawater also increased in 1995 but, as discussed for Hartlepool, the results of such measurements are highly variable and, in any case, of very low radiological significance.

Concentrations of other radionuclides in the aquatic environment represent the combined effects of releases from the stations, from other establishments which discharge into the Bristol Channel, from Sellafield, and from fallout. Apportionment is generally difficult at the low levels detected. However the carbon-14 content in seafood was likely to have been due to discharges from Amersham International, Cardiff. The concentrations of transuranic nuclides were of negligible radiological significance. Gamma radiation dose rates over intertidal sediment, measured using portable instruments, were difficult to distinguish from the natural background with the exception of the measurements close to the station which were affected by direct radiation from the reactors. The most exposed group from liquid discharges from the site in 1995 were represented by fishermen on the River Parrett who were estimated to receive an exposure of 0.008 mSv or 0.8% of the dose limit of 1 mSv.

9.7 Sizewell, Suffolk

At this establishment there are two stations. The 'A' station is powered by Magnox reactors whilst the 'B' station is powered by a PWR. Station 'B' began operation in 1995. Authorised discharges of radioactive liquid effluent from both power stations are discharged via adjacent outfalls to the North Sea. Gaseous wastes are discharged via separate stacks to the local environment. Environmental monitoring for the power stations is considered in a single programme covering the area likely to be affected. The results of monitoring in 1995 are shown in Tables 30 (a) and (b).

The aquatic programme comprised analysis of seafood and indicator materials and measurements of gamma and beta dose rates in intertidal areas. Concentrations of artificial radionuclides were low and mainly due to the distant effects of Sellafield discharges and to fallout. Trace levels of activation products were likely to have been due to discharges from the power stations though there was no conclusive evidence of the effects of the new 'B' station. In 1995, the radiation exposure of local fish and shellfish consumers was low, at less than 0.005 mSv or 0.5% of the dose limit of 1 mSv. Measured gamma and beta dose rates were indistinguishable from the natural background with the exception of the measurements close to the stations which were affected by direct radiation. The above exposure of the most exposed group includes a contribution for their external exposure based on a calculation using radionuclide concentrations in sediment.

Unplanned reactor blowdowns at the 'A' station in the last quarter of the year led to the Quarterly Notification Level for carbon-14 being exceeded. However, gamma spectrometry and analysis of tritium, carbon-14 and sulphur-35 in milk, crops and fruit showed very low levels of artificial radioactivity near the power stations. Trace quantities of sulphur-35 were detected in a single sample of blackberries. The estimated exposure of the most exposed group of consumers eating such foods was less than 0.008 mSv or 0.8% of the dose limit of 1 mSv. There has been no detectable increase in levels of radioactivity in foodstuffs due to the operation of the PWR.

9.8 Trawsfynydd, Gwynedd

This station is being decommissioned. Low level discharges continued during 1995 under authorisation of the Welsh Office and HMIP. Discharges of liquid radioactive waste were made to a freshwater lake making the power station unique in UK terms. The aquatic monitoring programme is directed at consumers of freshwater fish caught in the lake and external exposure over the lake shoreline; the important radionuclides are those of caesium and to a lesser extent, strontium-90. Habits surveys have established that species of fish regularly consumed are brown trout, rainbow trout and a small amount of perch. Perch and most brown trout are indigenous to the lake but rainbow trout are introduced from a hatchery. Because of the limited period which they spend in the lake, introduced fish generally exhibit lower radiocaesium concentrations than those of indigenous fish.

The results of the terrestrial programme, including those for local milk, crops and indicator materials are shown in Tables 31 (a) and (b). Concentrations of activity in all terrestrial foods were low, the most significant being those at about 10 Bq kg^{-1} of radiocaesium in ovine muscle and offal. The most likely source of radiocaesium in these and other samples is fallout from Chernobyl and weapons tests though it is conceivable that a small contribution may be made by resuspension of lake activity. In recognition of this potential mechanism, monitoring of transuranic radionuclides was also carried out in crop and animal samples. In all cases, detected activities were low, and similar to observations in other areas of England and Wales, where activity was attributable to background weapons fallout. No evidence was therefore found that resuspension of lake activity contributed to exposure from transuranic radionuclides in 1995.

The most exposed group for terrestrial foods at Trawsfynydd in 1995 were adults who were high rate consumers of ovine muscle and offal. Their exposures were less than 0.014 mSv or about 1% of the dose limit of 1 mSv. This assessed dose is dominated by the caesium activity detailed above and therefore contains a significant contribution from Chernobyl fallout.

In the lake itself, there remains clear evidence for the effects of discharges from the power station. Concentrations of caesium exceed 1000 Bq kg^{-1} in the mud from the bed of the lake and in peat from below the hydroelectric power station at Maentwrog though lower values tend to be found on the shoreline where occupancy by anglers is relevant. The water level of the lake was lower than usual in 1995 and the programme of measurement of gamma dose rates on the shoreline was increased to ensure that exposures remained well within limits. Small increases in gamma dose rates were observed but their overall significance, as indicated below, remained low.

There were also increases in the concentrations of caesium-137 in lake water which remain above those for water coming into the lake via the Afon Prysor. However these increases were small, and indeed, concentrations of caesium and other radionuclides in fish fell in 1995. Taking this and the results of measurements of gamma dose rates into account, the exposure of the most exposed group of anglers was 0.035 mSv in 1995, or less than 4% of the dose limit of 1 mSv. In 1994, their estimated exposure was 0.03 mSv (Camplin, 1995).

9.9 Wylfa, Isle of Anglesey

Gaseous and liquid wastes from this station were discharged in 1995 under authorisation of the Welsh Office and HMIP. Environmental monitoring of the effects on the Irish Sea and the local environment is carried out on behalf of the Welsh Office. Such discharges and effects are very low. The results of the programme in 1995 are given in Tables 32 (a) and (b).

The data for artificial radionuclides related to the Irish Sea continue to reflect the distant effects of Sellafield discharges though trace levels of activation products were likely to have been due to discharges from the station. The concentrations were generally similar to or less than those for 1994 though the increase in beta activity in *Fucus vesiculosus* may have been due to the sensitivity this species has as an indicator of increased discharges of technetium-99 from Sellafield. The exposure of the most exposed group of high-rate fish and shellfish consumers was low, at 0.005 mSv or 0.5% of the dose limit of 1 mSv. Gamma dose rates, measured using portable instruments, continued to be difficult to distinguish from the natural background, but a small contribution due to external exposure of the most exposed group has been included in the total above.

In relation to gaseous wastes, the mis-identification of a waste drum resulted in the limit for the activity in the material fed into the site incinerator being exceeded in August 1995. The level of activity involved was small and there was no detectable impact on the foodchain. A review of procedures has been carried out to prevent a re-occurrence.

The results for terrestrial foods indicate a small effect due to the total gaseous discharges from the power station. This is seen in the data for sulphur-35 in milk and barley. However, the exposure of high rate food consumers remained low at less than 0.006 mSv or 0.6% of the dose limit.

10. DEFENCE ESTABLISHMENTS

10.1 Aldermaston, Berkshire

The Atomic Weapons Establishment at Aldermaston is authorised to discharge low levels of radioactive waste to the environment. Liquid discharges are made to the River Thames at Pangbourne and to the sewage works at Silchester. The monitoring programme comprised of sampling of milk, other terrestrial foodstuffs, freshwater fish and indicator materials together with measurements of gamma dose rates near the main outfall on the River Thames. Monitoring of the aquatic environment at Newbridge is undertaken to indicate background levels remote from nuclear establishments.

The results of measurements of radioactivity concentrations and dose rates are shown in Tables 33(a) and (b). The concentrations of artificial radioactivity detected in the Thames catchment were generally very low. Leakage was discovered, in March, from a valve pit in the liquid discharge pipeline. As the area is occasionally used for rough grazing analyses of vegetation samples taken by AWE staff was carried out. This indicated that there was no significant impact on the foodchain. Iodine-131 was detected (110 Bq kg(dry weight)) in mud in Foudry Brook but the source of this nuclide is most likely to have been associated with medical applications. The gamma dose rate on the river bank at Pangbourne was indistinguishable from natural background. External exposures were therefore calculated using a model based on concentrations of radionuclides in sediment. Habits surveys have established that the most exposed group affected by discharges into the river comprises anglers whose occupancy of the river bank has been assessed to estimate their external exposures. No consumption of freshwater fish has been established, however the assessment has conservatively included consumption of fish at a low rate of 1 kg year^{-1}. The overall radiological significance of liquid discharges was very low: the radiation dose to anglers was much less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

The concentrations of radioactivity in milk, vegetables, fruit and terrestrial indicator materials were also very low. Results for tritium, uranium and transuranic radionuclides were similar to those for 1994 (MAFF, 1995). The most likely source of the radionuclides detected was natural background or weapons tests fallout. The maximum dose was assessed to be for the 1 year old age group. The dose in 1995, including contributions from the natural and fallout sources, was less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

10.2 Barrow, Cumbria

Whilst the site operated by Vickers Shipbuilding and Engineering Ltd at Barrow is not strictly a defence establishment, the small amounts of liquid radioactive wastes discharges to the Irish Sea are related to submarine activities and are therefore included in this section for completeness. The monitoring programme comprises measurements of gamma dose rates and analysis of sediments collected near the outfall. The results, given in Tables 34(a) and (b), show no enhancement due to site activities above the background to be expected in the Irish Sea at this distance from Sellafield. The external exposure of the most exposed group at the site was estimated to be 0.023 mSv, representing less than 3% of the dose limit of 1 mSv. Most of this exposure was due to historic discharges from Sellafield.

10.3 Chatham, Kent

Discharges of radioactive waste from Chatham no longer take place, however a small programme of gamma dose rate measurement and sediment analysis has continued in surveillance of the effects of past discharges. The results (Tables 34(a) and (b)) show that gamma dose rates continued to be indistinguishable from natural background and, that low levels of radioactivity were detected in sediments. The external exposure of the most exposed group was 0.005 mSv or 0.5% of the dose limit of 1 mSv.

10.4 Devonport, Devon

Discharges of liquid radioactive waste are made under authorisation by Devonport Management Ltd and the Ministry of Defence into the Tamar Estuary. The monitoring programme in 1995 comprised measurements of gamma dose rates and analysis of seafood and indicator materials. The results (Tables 34(a) and (b)) were similar to those in 1994 (Camplin, 1995). Trace quantities of fission and activation products and actinides were detected. The detection of iodine-131 is most likely to be related to its medical uses. The exposure of the most exposed group taking account of consumption of marine foods and occupancy times was estimated to be 0.012 mSv or 1% of the dose limit of 1 mSv. The radiological significance of this, in common with other defence establishments, continued to be low.

10.5 Greenwich, London

In order to monitor the potential effects of the small discharges of gaseous activity from the Royal Naval College at Greenwich, grass is sampled and analysed by gamma spectrometry. Two samples were analysed in 1995. One sample contained a small amount of caesium-137 above the limit of detection (1.0 ± 0.2 Bq kg^{-1}). This activity is typical of that expected due to the residual but radiologically insignificant effects of weapons tests and Chernobyl fallout in the area. Therefore there was no detected impact in the environment due to the operation of the site in 1995.

11. AMERSHAM INTERNATIONAL PLC

This company manufactures radioactive materials for use in medicine, research and industry. The company's principal establishment is located in Amersham, Buckinghamshire and it also operates from Cardiff in South Glamorgan and on the Harwell site. Discharges from the Amersham International PLC facility on the Harwell site are covered by the Harwell monitoring programme.

11.1 Amersham, Buckinghamshire

Discharges of liquid radioactive wastes are made under authorisation to the Maple Lodge sewage works; releases enter the Grand Union Canal and the River Colne. Discharges of gaseous wastes are also authorised. The monitoring programme consists of measurements of gamma dose rates on the river bank of the Union Canal and analysis of fish, milk, crops and indicator materials. Monitoring at Newbridge on the Thames acts as an indication of background levels in the catchment. Monitoring of non-food pathways is carried out by HMIP (HMIP, 1995).

The results of the measurements are presented in Tables 35(a) and (b). The concentration of carbon-14 in fish was enhanced above the background level (24 Bq kg^{-1} (wet weight)) but its radiological significance was low. Concentrations of other radionuclides, e.g. cobalt isotopes, were also slightly enhanced close to the outfall. However, the gamma dose rates on the river bank were indistinguishable from natural background.

The activity concentrations in milk and crops were generally lower than the limits of detection. However, low levels of sulphur-35 and iodine-125 were detected in a few crop samples.

Habit surveys have identified anglers as the most exposed group affected by discharges into the canal/ river system. Their occupancy of the river bank has been assessed to estimate their external exposures. Consumption of freshwater fish was also considered but none was found. Nevertheless, it is considered prudent to include a component in the assessment of the anglers exposure and a hypothetical consumption of fish at a rate of 1 kg $year^{-1}$ was assumed. The anglers exposure in 1995 was much less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

The exposure of the most exposed group of terrestrial food consumers was assessed as being less than 0.011 mSv or 1% of the dose limit.

11.2 Cardiff

A second laboratory, situated near Cardiff, produces labelled compounds used in research and diagnostic kits used in medicine for the *in vitro* testing of clinical samples. Revised authorisations were issued by HMIP and the Welsh Office in 1995 to regulate disposals of waste from the establishment. These new authorisations reduced the limits on the discharges. Liquid wastes are discharged into the Severn estuary via the sewer system.

Monitoring, carried out on behalf of the Welsh Office, includes consideration of consumption of food and external exposure over muddy, intertidal areas. Measurements of external exposure are supported by analyses of intertidal sediment. Indicator materials including seawater, *Fucus* seaweed, grass, rape, silage and dry cloths provide additional information.

The results of monitoring in 1995 are presented in Tables 36(a) and (b). The main effect of liquid discharges is seen in increases of carbon-14 activities above those expected due to background. Similar values to those found in 1994 were observed (Camplin, 1995). Concentrations of other radionuclides in aquatic samples were low and can be explained by other sources such as fallout and discharges from other establishments. Gamma dose rates over sediment, as measured using portable instruments, were difficult to distinguish from those expected from the natural background. The exposure of the most exposed group of fish and shellfish consumers including external radiation was 0.012 or 1% of the dose limit of 1 mSv.

The main effects of gaseous discharges were seen in results for tritium and carbon-14, and levels of the latter were increased, as compared to 1994, due to an increased workload at the site. Concentrations of tritium, organically bound tritium and carbon-14 were found to be higher in milk sampled from farms close to the site than from farms far from the site. When compared with data for other sites, relatively high concentrations of these nuclides were also detected in other terrestrial samples such as barley and grass. However, the concentrations of other radionuclides were low and rarely above the limits of detection. Calcium-45 was detected in grass (7.2 Bq/kg) and in oilseed rape (11 Bq/kg) but was not measured above the limit of detection in foodstuffs consumed directly by man. These measurements are not of radiological significance.

The maximum estimated exposure from food consumption was to the 1 year old age group. The most exposed group dose received <0.027 mSv or 3% of the dose limit of 1 mSv. The largest contribution was from carbon-14 in milk.

12. MINOR SITES AND EURATOM SAMPLING

Four minor sites with very low levels of discharge are monitored using a small programme of sampling indicator materials. The results, given in the following sub-sections, show that there was no detected impact on the environment in 1995 due to operation of these sites. This section also presents the results of indicator sampling around the major nuclear sites carried out in relation to the Euratom Treaty.

12.1 Imperial College Reactor Centre, Ascot, Berkshire

Four grass samples were analysed by gamma spectrometry. All results in 1995 were less than the limits of detection.

12.2 Imperial Chemical Industries plc, Billingham, Cleveland

Three grass samples were analysed by gamma spectrometry. All results in 1995 were less than the limits of detection with the exception of a single sample which contained a small amount of caesium-137. The mean concentration of caesium-137 was 0.6 ± 0.1 Bq kg^{-1} which is typical of that expected due to the residual but radiologically insignificant effects of weapons tests and Chernobyl fallout in the area.
This reactor ceased operation on 28 June 1996.

12.3 Rolls Royce plc, Derby, Derbyshire

Results of monitoring at Derby are presented in Table 37. Uranium activity detected in grass and soil samples was similar to results obtained in 1994 (MAFF, 1995). Isotopic analysis of the grass samples confirmed that the activity was not enriched in uranium-235. The activities detected are therefore due to natural sources.

In September 1995 a power failure resulted in enhanced levels of uranium discharge. Additional monitoring was carried out and no impact on the food chain or environment could be detected.

12.4 Universities Research Reactor Centre, Risley, Cheshire

Eight grass samples were analysed by gamma spectrometry. All results in 1995 were less than the limits of detection. This site has now been decommissioned and will not therefore be monitored in the future.

12.5 Euratom sampling

In accordance with the requirements of Articles 35 and 36 of the Euratom Treaty, each member state is obliged to monitor levels of radioactivity near nuclear facilities and provide information from this programme to the Commission. A programme of grass and soil monitoring to fulfil these requirements was established in 1993 in England and Wales (MAFF, 1995). The results of the programme in 1995 are presented in this sub-section and will be submitted to the Commission of the European Union in fulfilment of the Treaty obligation. Supplementary information on grass and soil analyses is provided for some sites in the foregoing site-specific sub-sections.

The programme consists of annual sampling of paired grass and soil samples from three permanent plots at each site, generally situated 500 m from the site perimeter along the three dominant landward wind directions. In 1995 samples continued to be analysed for carbon-14, strontium-90, caesium-137 and plutonium-239+240. Tritium, sulphur-35, plutonium-238 and americium-241 analyses were also performed in 1995 on all or a sub-set of the samples obtained in order to meet a change in the programme specification. The results are given in Table 38.

The mean concentrations of tritium ranged from 13 to 690 Bq kg^{-1} in grass. However, at only one site, Cardiff, did the mean concentration exceed 100 Bq kg^{-1}. The maximum concentration observed, 1500 Bq kg^{-1}, was also observed at this site. The next highest concentration, 170 Bq kg^{-1}, was found at Winfrith. No analyses were performed at Sellafield. Taken together these results are to be expected given the relative discharges of tritium from each site (Table 2).

Carbon-14 activity concentrations depend on the carbon content of the samples and are highly variable. Interpretation of the data without a knowledge of the carbon content is therefore difficult. Nevertheless, taken with other site-specific data some general conclusions may be drawn. Typical ranges of mean concentrations in grass and soil were 100-200 and 10-20 Bq kg^{-1} respectively. Sites where concentrations were found well outside these ranges were

- Cardiff 620 Bq kg^{-1} in grass
  73 Bq kg^{-1} in soil
- Dungeness 98 Bq kg^{-1} in soil and
- Trawsfynydd 48 Bq kg^{-1} in soil

Of these sites, the carbon-14 signal is clearest at Cardiff and is supported by data on other materials (see Cardiff sub-section). The observation of a significant enhancement of carbon-14 levels near Sellafield in 1994 (MAFF, 1995) was not repeated in 1995. This is probably due to the large reduction in discharges of this nuclide in gaseous wastes from this site (1993: 7.4 TBq; 1994: 1.0 TBq; 1995: 0.71 TBq). Gaseous wastes have been diverted to a liquid stream.

Mean concentrations of sulphur-35 in grass and soil were typically in the ranges 5-20 and 1-5 Bq kg^{-1} respectively. Significant variations outside these ranges were found at

- Amersham 47 Bq kg^{-1} in grass
- Oldbury 200 Bq kg^{-1} in grass and
- Hinkley Point 10 Bq kg^{-1} in soil

The high level detected in grass at Oldbury was not reflected in the results of other monitoring carried out in the vicinity of the site.

Means concentrations of strontium-90 were generally less than 10 Bq kg^{-1} in grass and soil and similar to values for 1994 (MAFF, 1995). Those in excess of this level were found at

- Sellafield 45 Bq kg^{-1} in grass
  24 Bq kg^{-1} in soil and
- Dungeness 26 Bq kg^{-1} in soil

Evidence of enhancement of strontium-90 due to site discharges from Sellafield has been found previously (MAFF, 1995) and is reflected in samples of other materials from the site. In contrast, there is no strong evidence to suggest that the observation of a relatively high level of strontium-90 in soil at Dungeness is linked to discharges from the site and fallout from weapons test is the most likely source.

Mean caesium-137 concentrations in grass and soil were generally similar to those in 1994, with levels in grass being less than 10 Bq kg^{-1} and in soil being less than 100 Bq kg^{-1}. As previously found, higher levels were observed at Sellafield, Trawsfynydd and Dungeness. The long term effects of fallout from weapons tests and Chernobyl would have played a significant part in determining these differences.

As was found in 1994, mean plutonium-239+240 concentrations detected in grass from Sellafield, ~1 Bq kg^{-1}, were significantly higher than those at other sites which were in the range <0.010-0.05 Bq kg^{-1}. In soil, higher concentrations than the norm were found at Dungeness (3.5 Bq kg^{-1}), Sellafield (16 Bq kg^{-1}) and Trawsfynydd (2.7 Bq kg^{-1}). A typical level at other sites was less than 0.5 Bq kg^{-1}. Fallout from weapons testing will have had a major influence on these levels. However, taken with the observations for plutonium-238, there is evidence for a site related effect at Sellafield. The expected ratio of plutonium-239+240/ plutonium-238 in fallout is about 40. That in recent discharges from Sellafield is less than 10. The observed ratios in grass and soil near Sellafield in 1995 were 8 and 19 respectively.

An indication of the potential radiological significance of these measurements can be given by comparing the levels with the appropriate Generalised Derived Limits (GDLs) for these radionuclides. GDLs for grass and soil are activity concentrations which correspond to an exposure of 1 mSv. They are based on simple, conservative models and as such do not provide a realistic assessment of exposures (Attwood *et al* 1996). Their main use is in screening monitoring results to establish whether specific studies should be undertaken. Table 39 compares the highest observed concentrations in grass and soil with the relevant GDLs. This comparison is not strictly valid as GDLs are derived for well mixed soil to a depth of 300 mm whereas the soil samples taken as part of this programme are to a depth of 70 mm. Generally, the highest mean concentrations observed were lower than, often very much lower than, the 10% trigger level for site-specific investigations. However at Cardiff and Dungeness, values in excess of 10% were observed. The site-specific assessments for these sites were considered in earlier sub-sections of this report. These assessments evaluate the dose received using the activities found in locally produced foods and show that the doses were significantly less than 0.1 mSv.

13. INDUSTRIAL SITES

13.1 Albright and Wilson Ltd, Whitehaven, Cumbria

In view of the radiological importance of natural radionuclides to fish and shellfish consumers (Pentreath *et al.,* 1989; Rollo *et al*., 1992; Camplin *et al*., in press), a small programme of monitoring for these radionuclides in the UK marine environment has continued. Previous surveys (Rollo *et al.,* 1992) have established that an important man-made source was the Albright and Wilson chemical plant at Whitehaven in Cumbria which has manufactured phosphoric acid from imported phosphate ore. Phosphogypsum, a waste product of this process, has been discharged as a liquid slurry by pipeline to Saltom Bay. The radioactive waste discharges are authorised by HMIP and contain low levels of natural radioactivity consisting mainly of thorium, uranium and their daughter products. Discharge rates during 1995 were much less than those made previously due to changes in waste treatment techniques and the cessation of use of phosphate ore in 1992.

The results of monitoring for natural radioactivity near the site in 1995 are shown in Table 40.

Analytical effort has focused on lead-210 and polonium-210 which concentrate in marine species and are the important radionuclides in terms of potential dose to the public. Concentrations of polonium-210 and other natural radionuclides are enhanced near Whitehaven but quickly reduce to background levels further away. Concentrations of polonium-210 and lead-210 were generally lower than in 1994 due to reductions in discharges and radioactive decay of activity already in the environment. Figure 5 shows how concentrations of polonium-210 in winkles have decreased substantially since 1989. It also demonstrates the seasonal variations in concentrations which have been previously observed (Rollo *et al*., 1992). The critical radiation exposure pathway is internal irradiation, due to the ingestion of natural radioactivity in local fish and shellfish. In this assessment, the contribution due to background levels of natural radionuclides has been subtracted. The most

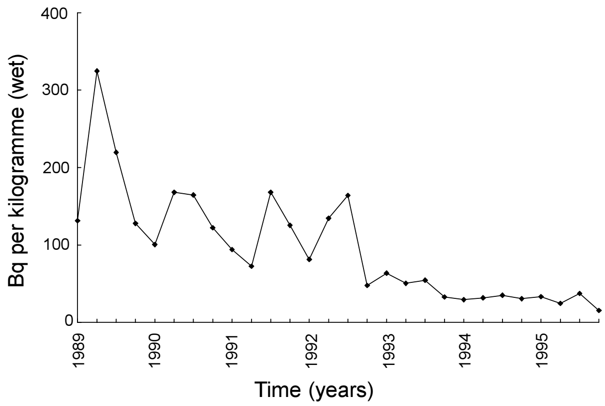

Figure 5. Polonium-210 in Parton winkles

exposed group consists of people who consume seafood collected from Saltom Bay and Parton. Consumption rates were reviewed in 1995 and small changes to fish and shellfish data were made. The exposure to the most exposed group in 1995 was 0.18 mSv on the basis of the current generic ICRP advice for a gut transfer factor of 0.5 for polonium. This advice is to be applied in the absence of specific information.

As discussed in Section 6, a specific research study involving the consumption of crab meat containing natural levels of polonium-210 provides evidence for a gut transfer factor of 0.8 for polonium. Estimates of exposures due to polonium intakes due to consumption of seafood have therefore also been calculated using the conservative assumption that the value of 0.8 applies to the total intake of polonium. These data indicate that the most exposed group dose has reduced from 0.34 mSv in 1994 (Camplin, 1995) to 0.29 mSv in 1995. The estimated doses in 1995 are therefore well within the dose limit for members of the public of 1 mSv.

The fish and shellfish consumed by the most exposed group also contains artificial radionuclides due to Sellafield discharges. The additional exposure due to artificial radionuclides has been calculated using data from Section 4. In 1995 these exposures added a further 0.054 mSv to the doses above resulting in a total dose to this group of 0.34 mSv.

13.2 Other industrial sites

Levels of natural radionuclides in gaseous wastes from some large scale industrial activities also have the potential to raise the radionuclide concentrations in foodstuffs. Examples of such activities are combustion of fossil fuels and metal or phosphate ore processing. Since 1991, a small rolling programme to examine the effects of these activities has been carried out. In 1995 three sites were chosen for study:

- Eggborough, North Yorkshire, - a coal fired power station
- Ellesmere, Cheshire, - an oil refinery and
- Milford Haven, Pembrokeshire, - an oil refinery

Marloes, Pembrokeshire was chosen as a control site for purposes of comparison.

The results of the sampling of grass, soil and animals in 1995 is given in Table 41. The analyses performed included ones for man-made radionuclides in order to rule out the possibility that there was an unforeseen mechanism whereby the general levels of such nuclides were enhanced.

The concentrations of natural radionuclides in grass and soil were all within the ranges expected for natural sources. Monitoring at Eggborough in 1994 had produced results indicating that the power station may have contributed measurable amounts of unsupported polonium-210 to some grass samples (MAFF, 1995). However this was not observed in 1995.

The concentrations of man-made radionuclides in all samples were all low and typical of those to be expected due to sources such as weapons tests and Chernobyl fallout.

14. LANDFILL SITES

Some landfill waste disposal sites are authorised by HMIP to receive solid wastes containing very low levels of radioactivity. There is potential for the radioactivity in wastes disposed of in this way to migrate in groundwater and in leachates to surrounding farmland. Monitoring of leachates is carried out by HMIP (HMIP, 1995). Once covered over, landfill sites may also be converted back to agricultural use. In recognition of this, the programme includes monitoring of indicator materials (plants) collected near such sites. In 1995 the sites chosen were:

- Clifton Marsh, Lancashire
- Cowpen Bewley, Cleveland
- Cilgwyn Quarry, Gwynedd and
- Milton, Cambridge

Grass samples were collected at each site except Cilgwyn, where samples of nettles were obtained. Mean concentrations of tritium up to 100 Bq kg^{-1} were detected which were of the same order as values detected in 1994. These values are an order of magnitude lower than those which can be detected in grass in the vicinity of some nuclear sites and are of negligible radiological significance. Nevertheless, results for individual samples at Clifton Marsh, Cilgwyn and Milton were observed in excess of 100 Bq kg^{-1} giving support to the observation that this nuclide is present in some landfill sites (HMIP, 1995). The results for other nuclides were typical of those expected due to natural background, weapons tests or Chernobyl fallout. These results are summarised in Table 42.

15. CHERNOBYL FALLOUT

The programme of monitoring in relation to the effects of fallout from this accident has continued in 1995. Caesium is still being detected in sheep grazing certain upland areas in the UK which were subjected to heavy rainfall after the Chernobyl accident in 1986. Restrictions are still in place on the movement and slaughter of sheep from these areas in order to prevent animals with high levels of caesium entering the food chain.

In the summer of 1995 an intensive monitoring survey of over 100,000 sheep in the post-Chernobyl restricted areas of Cumbria and North Wales was carried out. The results of the survey enabled restrictions to be lifted on more than 30 holdings leaving fewer than 410 within the restricted areas. This represents a reduction of 94 % since 1986 when over 6770 holdings were under restriction.

In addition, the radiocaesium monitoring of sheep carcasses at slaughter-houses has continued. The mean result of all English and Welsh samples analysed in 1995 was 40 Bq/kg and the highest result was 414 Bq/kg. This compares with the action level of 1000 Bq/kg of caesium recommended by the EC expert committee in 1986.

Further information and results are published in a MAFF news release (MAFF 1996) (reference MAFF 15/96 of 17 January 1996) and a Welsh Office press release (Welsh Office 1996)

Sampling locations for freshwater fish were mostly in areas of relatively high deposition of fallout from Chernobyl, namely Cumbria, North Wales and parts of Scotland. Samples from areas of low deposition in England were also obtained for completeness and comparison.

Table 43 presents concentrations of caesium-134 and -137 in fish and water. Artificial radionuclides, other than those of radiocaesium were, in 1995, no longer detectable from the Chernobyl accident.

Concentrations of radiocaesium in freshwater fish varied between locations, reflecting the areas of deposition of radioactivity from Chernobyl and the small sampling programme. Perch had the highest concentrations of any of the freshwater species but, as they are not eaten in large quantities, their radiological significance is low. Concentrations in all species were less than 1000 Bq kg^{-1}. Where there are data for the same species and locations to compare with results for 1994 (Camplin, 1995) there are likely to be large statistical fluctuations because of the small sampling programme, but concentrations of radiocaesium were generally similar in 1995 to those in 1994. Figure 6 shows a plot of mean total radiocaesium concentrations in brown trout from Ennerdale Water against time. In recent years the rate of decline has reduced and it is likely that levels have now become more stable.

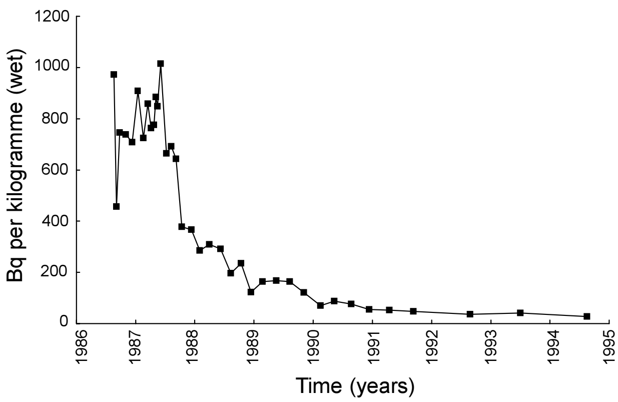

Figure 6. Radiocaesium in brown trout – Ennerdale Water

Radiation exposures have been estimated using a procedure based on cautious assumptions, as previously (Camplin, 1995). A consumption rate of brown trout of 37 kg $year^{-1}$, sustained for one year, was taken to be an upper estimate for adults subject to the highest exposures. Actual exposures are likely to be lower, not only because this consumption rate is cautious (Leonard *et al*., 1990) but also because, in practice, hatchery-reared or farmed fish of much lower radiocaesium concentrations may contribute to the diet. In 1995, estimated exposures were less than 0.1 mSv.

The ICRP (ICRP, 1993) provides guidance in the context of emergencies, which includes suggested levels of averted dose above which particular countermeasures would almost certainly be justified. It recommends that intervention should be taken by restricting a single foodstuff if the averted effective dose is in excess of 10 mSv in a year. Given that the dose estimates here are cautious, it is clear that the residual contamination of freshwater fish from fallout from Chernobyl is only of minor radiological importance.

16. REGIONAL MONITORING

This section presents the results of regional monitoring in areas of the British Isles. The component parts of the programme considered in subsequent sub-sections cover:

- The Isle of Man
- The Channel Islands
- General diet in England and Wales
- Milk in England, Wales and Northern Ireland
- Crops in England and Wales and
- Seawater surveys in the British Isles

16.1 Isle of Man

MAFF carries out an on-going programme of radioactivity monitoring on behalf of the Department of Local Government and the Environment on the Isle of Man for a wide range of terrestrial foodstuffs. Results are reported in Isle of Man Government press releases in addition to this report. Results of monitoring of aquatic foodstuffs are presented in Section 7.

Radioactivity monitoring of terrestrial foods on the Island serves two purposes: firstly to monitor the continuing effects of radiocaesium deposition resulting from the Chernobyl accident in 1986 and secondly to respond to public concern over the effects of the nuclear industry. The potential sources of exposure from the UK nuclear industry are: (i) liquid discharges into the Irish sea and sea-to-land transfer; and (ii) gaseous discharges of tritium, carbon-14 and sulphur-35 and atmospheric transport.

The results of monitoring for 1995 are presented in Table 44. Tritium, cobalt-60, ruthenium-106 and cerium-144 activity was not detected above the LoD in any of the Manx food samples monitored. Carbon-14 was detected in local milk and crops at activity concentrations similar to the natural background values observed in the regional network of sampling locations remote from nuclear sites. Levels of strontium-90, caesium-137, plutonium isotopes and americium-241 detected in local milk and crops were all similar to the values observed in the regional networks of UK dairies and crop sampling locations remote from nuclear sites, at those locations known to have received similar levels of Chernobyl and weapons fallout. Levels of these radionuclides in local animals were also similar to levels in animals from other sampling locations unaffected by Sellafield discharges. These results demonstrate that there was no measurable impact on Manx agriculture from operation of mainland nuclear installations in 1995.

These 1995 data were similar to results obtained in previous years. The exposure of the most exposed group from consumption of these Manx foodstuffs monitored in 1995 was less than 0.024 mSv or 3% of the dose limit of 1 mSv.

16.2 Channel Islands

Marine environmental samples provided by the Channel Island States have continued to be analysed, mainly in surveillance of the effects of radioactive liquid discharges from the French reprocessing plant at Cap de la Hague. The programme also serves to monitor the potential effects of historic disposals of solid waste in the Hurd Deep. Fish and shellfish are monitored in relation to the internal irradiation pathway; sediment is analysed with relevance to external exposures. Sea water and seaweeds are sampled as indicator materials and, in the latter case, because of their use as fertilisers. The results for 1995 are given in Table 45. Concentrations of activity in fish and shellfish were low and similar to those in previous years. Apportionment to different sources, including fallout, is difficult in view of the low levels detected. A theoretical assessment based on a pessimistic choice of consumption rates and occupancy gives an estimated exposure of 0.009 mSv in 1994 or 0.9% of the dose limit for members of the public. The concentrations of artificial radionuclides in the marine environment of the Channel Islands therefore continued to be of negligible radiological significance.

16.3 Diet in England and Wales

As part of MAFF's general responsibility for food safety, radioactivity in whole diet is determined on a regional basis. Measurements are made on samples of mixed diet from nine regions in England and Wales. The system of sampling mixed diet rather than individual foodstuffs from specific locations, provides more accurate assessments of radionuclide intakes because people rarely obtain all their food from a local source (Mondon and Walters, 1990). Radionuclides of both natural and man-made origins were measured in samples in 1995. The results are provided in Table 46.

All of the results for man-made radionuclides were low and of little radiological significance. Concentrations of tritium were variable ranging from 4.5 to 82 Bq kg^{-1}, however, there was no discernible regional pattern to the distribution when compared with data for 1993 and 1994 (MAFF, 1995). Sulphur-35, strontium-90, caesium-137 and actinide activity concentrations results were below or close to the limit of detection and were similar to levels in previous years.

Exposures as a result of consuming diet at average rates at the concentrations given in Table 46 have been assessed for adults, infants and ten year old children. In all cases the exposures of infants were higher than other age groups. The data are summarised in Table 47. The most important man-made radionuclide was strontium-90, derived from weapons tests' fallout. The nationwide mean exposure for all man-made radionuclides was 0.008 mSv with a range from region to region of 0.004 to 0.016 mSv. These exposures are not directly comparable with those published for 1993 and 1994 because calculations have been carried out for 10 year olds in the past. However, when data for the same age groups are compared, doses have been found to change little from year to year.

The mean concentration of carbon-14 in diet in 1995 was 43 Bq kg^{-1} with a range from 35 to 61 Bq kg^{-1}. In previous years, the mean values have been 33 and 38 Bq kg^{-1} for 1993 and 1994, respectively. Given the variability of results from region to region, it is unlikely that the trend of a small increase from year to year is significant, though the general expectation is for a small reduction from year to year due to the Suess effect (the diluting of carbon-14 by carbon-12 released by the burning of fossil fuels) and dispersion of weapons tests' fallout (Collins *et al.,* 1995). This situation will continue to be monitored in 1996.

Concentrations of lead-210 varied by an order of magnitude in samples of diet but the mean concentration, 0.049 Bq kg^{-1} was similar to that for polonium-210 of 0.039 Bq kg^{-1}. Concentrations of radium-226 and uranium were similar to those in 1994 (MAFF 1995).

The mean exposure due to consumption of natural radionuclides was 0.12 mSv, ranging from 0.091 to 0.20 mSv across the regions. The most important radionuclides were lead-210 and polonium-210 as established in earlier studies (MAFF, 1995). Significant contributions would also have been made by potassium-40 [e] and other members of the uranium-238 and thorium-232 decay series which were not determined in this year's analytical schedule. Further data for these nuclides is provided by MAFF (1995). Nevertheless it remains true that the results continue to demonstrate that natural radionuclides are by far the most dominant source of exposure in the average diet in England and Wales.

16.4 Milk from dairies in England, Wales and Northern Ireland

The programme of milk sampling in England, Wales and Northern Ireland continued in 1995. Samples were collected monthly from twenty five counties and analysed for natural and man-made radionuclides. Measurements for lead-210 and polonium-210 were included for the first time this year, and the analyses for uranium and plutonium were extended to include all counties. The programme, together with that for crops presented in the following sub-section, provides useful information with which to compare data from farms close to nuclear sites and other establishments which may enhance concentrations above background levels.

Where measurements are comparable, detected activity concentrations of all radionuclides in 1994 were similar to those for previous years. These results are summarised in Table 48. Uranium and plutonium results were either very close to or below their respective limits of detection. Results for tritium were consistently below the routine limit of detection of 10 Bql^{-1}. Where lower limits of detection were used, the maximum concentration observed was 3.0 Bq l^{-1} which is similar to the value detected in rain of 4.8 Bq l^{-1} (Playford *et al.*, 1995). Mean and maximum values for carbon-14 from all dairies were similar and at expected background levels.

Most of the results for strontium-90 were below the limit of detection. Where lower limits were specified for selected counties, the concentration detected was approximately 0.04 Bq l^{-1} which is in good agreement with results from other surveillance studies (Smith *et al.*, 1994a).

The levels of radiocaesium in dairy milk were highest from regions that received the greatest amounts of Chernobyl fallout. Thus highest concentrations were detected in samples from dairies in Northern Ireland. The results were in good agreement with those from the NRPB surveillance programme which showed mean levels in England and Wales of 0.04 and 0.05 Bq l^{-1} respectively, and those in Northern Ireland to be 0.22 Bq l^{-1} (Smith *et al.,* 1994a).

The assessed doses from consumption of dairy milk at average rates were highest to the one year old infant age group. They ranged from <0.026 to <0.061 mSv and were dominated by the presence of the natural radionuclides lead-210 and polonium-210. Man-made radionuclides contributed no more than a few µSv to these exposures.

16.5 Crops in England and Wales

The programme of monitoring natural and man-made radionuclides in crops continued in 1995. Tritium activity was below the limit of detection in all samples except one of leafy green vegetables from Cheshire where 26 Bq kg^{-1} was detected. The radiological significance of this level of activity is negligible but its detection lends support to the thesis that the widespread use and disposal of tritium activity in, for example, light sources is becoming detectable in the wider environment. Such observations are unlikely to be connected with the disposal of wastes from the nuclear industry. The activities of carbon-14 detected in crop samples were those expected from consideration of background sources.

The highest levels of strontium-90 activity were detected in crop samples from the south west of England as in 1994. This supports the observation made previously (MAFF, 1995) that the distribution of strontium-90 activity is related to the pattern of fallout from nuclear weapons testing. Caesium activity was largely below the limit of detection though a few samples from Cornwall and Cumbria yielded positive values. However, all were below 1 Bq kg^{-1}. Plutonium and americium-241 results were all low, below 0.003 Bq kg^{-1}, and were similar to those observed for 1994 (MAFF, 1995).

Levels of the natural radionuclides, lead-210, polonium-210, thorium-232 and uranium were also similar to those observed in 1994 (MAFF, 1995).

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[e] *The body content of potassium is homeostatically controlled thus an increased intake of potassium containing the equilibrium concentration of potassium-40 will not result in a higher dose.*

16.6 Seawater surveys

Seawater surveys support international studies concerned with the quality status of coastal seas (e.g. OSPAR, 1993b) and provide information which can be used to distinguish different sources of man-made radioactivity (e.g. Kershaw and Baxter, 1995). In addition, the distribution of radioactivity in sea water around the British Isles is a major factor in determining the variation in individual exposures at coastal sites as well as collective doses. Therefore a programme of surveillance into the distribution of key radionuclides is maintained using research vessels and other means of sampling. Detailed historical data on radiocaesium in sea water have been published in a series of reports to aid model development (Camplin and Steele, 1991; Baxter *et al.,* 1992; Baxter and Camplin 1993(a-c)) and have been used to derive dispersion factors for nuclear sites (Baxter and Camplin, 1994). The research vessel programme on radionuclide distribution currently comprises cruises in the Irish Sea, Scottish waters and the North Sea every two or three years. The results of the 1993 cruises have been summarised by Camplin (1994) and further cruises are planned for 1996. Data from shoreline sampling in the Irish Sea and Scottish waters in 1995 are given in Table 50.

Concentrations of caesium-137 typical of the north-eastern Irish Sea and northern Scottish waters were of the order of 0.05-0.5 Bq l^{-1} and 0.01-0.02 Bq l^{-1} respectively. These data show similar levels to those observed from the more detailed sampling in 1993, the general distribution being one of falling concentrations as the distance from Sellafield increases. This distribution is governed by recent discharges from the Sellafield site and the effects of activity previously discharged which had become associated with seabed sediments but is now being remobilised into the water column. However the concentrations now observed are only a small percentage of those prevailing in the late 1970s, typically 30 Bq l^{-1} (Baxter *et al.,* 1992), when discharges were substantially higher.

17. RESEARCH IN SUPPORT OF THE MONITORING PROGRAMME

MAFF has an extramural programme of special surveillance investigations and supporting research and development studies to complement the routine surveillance undertaken. This additional work has the following objectives:

- to evaluate the significance of potential sources of radionuclide contamination of the foodchain;
- to identify and investigate specific topics not currently addressed by the routine surveillance programmes and the need for their inclusion in future routine surveillance;
- to develop and maintain site-specific habit and agricultural practice data, in order to improve the realism of dose assessment calculations;
- to develop more sensitive and/or efficient analytical techniques for measurement of radionuclides in natural matrices;
- to evaluate the competence of laboratories radiochemical analytical techniques for specific radionuclides in food;
- to develop improved methods for handling and processing surveillance data.

A list of related R & D projects completed in 1995 is presented in Table 51. Copies of the final reports for each of these projects are available from the MAFF library at Nobel House. Table 51 also provides information on projects which are currently underway. The results of these projects will be made available in due course.

18. REFERENCES

ATTWOOD, C.A., TITLEY, J.G.., SIMMONDS, J.R., AND ROBINSON, C.A.,1996. Generalised derived limits for radioisotopes of strontium, ruthenium, iodine, caesium, plutonium, americium and curium. Docs. NRPB 7(1). NRPB, Chilton, 34pp.

BAXTER, A.J., CAMPLIN, W.C. AND STEELE, A.K., 1992. Radiocaesium in the seas of northern Europe: 1975-79. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, (***28***): 1-166.

BAXTER, A.J. AND CAMPLIN, W.C., 1993(a). Radiocaesium in the seas of northern Europe: 1970-74. Fish. Res. Data Rep., MAFF Direct. Fish Res., Lowestoft, (***30***): 1-111.

BAXTER, A.J. AND CAMPLIN, W.C., 1993(b). Radiocaesium in the seas of northern Europe: 1962-69. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, (***31***): 1-69.

BAXTER, A.J. AND CAMPLIN, W.C., 1993(c). Radiocaesium in the seas of northern Europe: 1985-89. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, (***32***): 1-179.

BAXTER, A.J. AND CAMPLIN, W.C., 1994. The use of caesium-137 to measure dispersion from discharge pipelines at nuclear sites in the UK. Proc. Instn. Civ. Engrs. Wat., Marit. And Energy, ***106***: 281-288.

BRENK, H.D., ONISHI, Y., SIMMONDS, J.R. AND SUBBARATNAM, T., (UNPUBLISHED). A practical methodology for the assessment of individual and collective radiation doses from radionuclides in the environment. International Atomic Energy Authority draft working document no. 1987-05-06, Vienna.

Byrom, J., Robinson, C.A., Simmonds, J.R. and Walters, C.B.., 1995. Food consumption rates for use in generalised radiological dose assessments. J. Rad. Prot., ***15(4)*** 335-342.

Camplin, W.C., Tipple, J.R., Doddington, T.C., Thurston, L.M. and Hiller, R., 1990. A survey of tritium in sea water in Tees Bay, July 1986. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, ***(23)***:

Camplin, W.C and Steele, A.K., 1991. Radiocaesium in the seas of northern Europe: 1980-84. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, (***25***): 1-174.

Camplin, W.C., 1994. Radioactivity in surface and coastal waters of the British Isles, 1993. Aquat. Environ. Monit. Rep., MAFF Direct. Fish. Res., Lowestoft, (***42***): 1-107.

Camplin, W.C., 1995. Radioactivity in surface and coastal waters of the British Isles, 1994. Aquat. Environ. Monit. Rep., MAFF Direct. Fish. Res., Lowestoft, (***45***): 1-111.

Camplin, W.C., Baxter, A.J. and Round, G.D., (in press). The radiological impact of discharges of natural radionuclides from a phosphate plant in the United Kingdom. Int. Environ.

Collins, C. and Otlet, R., 1995. Carbon-14 levels in UK foodstuffs. MAFF Project B1408.

Cotter, A.J.R., Myatt, A., Hunt, G.J. AND Walters, C.B., 1992. Monitoring of radioactivity in the UK environment: an annotated bibliography of current programmes. Fish. Res. Data Rep., MAFF Direct. Fish. Res., Lowestoft, (***27***): 1-51.

Commission of the European Communities, 1980. Council directive of 15 July 1980 amending the directives laying down the revised basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation. Off. J. Eur. Commun., ***23*** (***L246***): 1-2.

Department of the Environment, 1996. Digest of environmental statistics, (***18***): 1-226. DoE, London.

HMIP, 1995. Monitoring programme. Radioactive Substances Report for 1994. Her Majesty's Inspectorate of Pollution, London, 37 pp.

Hughes, J.S., and O'Riordan, M.C., 1993. Radiation exposure of the UK population - 1993 review. National Radiological Protection Board, Chilton, 61pp (NRPB-R263)

Hunt, G.J., 1984. Simple models for prediction of external radiation exposure from aquatic pathways. Radiat. Prot. Dosim., ***8***: 215-224.

Hunt, G.J., 1985. Timescales for dilution and dispersion of transuranics in the Irish Sea near Sellafield. Sci. Total Environ., ***46***: 261-278.

Hunt, G.J., 1992. External doses to the public from beta-emitters in the aquatic environment near Springfields and Sellafield, J. Radiol. Prot., ***12***(***4***): 233-238.

Hunt, G.J., 1995. Radiation doses to critical groups since the early 1950s due to discharges of liquid radioactive waste from Sellafield. *In*: 'International Symposium on Environmental Impact of Radioactive Releases'. IAEA, Vienna, IAEA-SM-339/16.

Hunt, G.J. and Kershaw, P.J., 1990. Remobilisation of artificial radionuclides in the sediment of the Irish Sea. J. Radiol. Prot., ***10***(***2***): 147-151.

Hunt, G.J., Hewitt, C.J. and Shepherd, J.G., 1982. The identification of critical groups and its application to fish and shellfish consumers in the coastal area of the north-east Irish Sea. Hlth Phys., ***43***: 875-889.

Hunt, G.J., Leonard, D.R.P. and Lovett, M.B., 1986. Transfer of environmental plutonium and americium across the human gut. Sci. Total Environ., ***53***: 89-109.

Hunt, G.J., Leonard, D.R.P. and Lovett, M.B., 1990. Transfer of environmental plutonium and americium across the human gut. Sci. Total Environ., ***90***: 273-282.

Hunt, G.J.and Allington, D.J., 1993. Absorption of environmental polonium-210 by the human gut. J. Radiol. Prot. ***13*** (***2***), 119-126.

International Atomic Energy Agency, 1996. International basic safety standards for protection against ionizing radiation and for the safety of radiation sources. Saf. Ser. No. 115 Int. Atom. En. Ag., Vienna.

International Commission on Radiological Protection, 1977. Recommendations of the International Commission on Radiological Protection. Annal. ICRP ***1***(***3***). Pergamon Press, Oxford, 53pp. (ICRP Publ. (***26***)).

International Commission on Radiological Protection, 1991. 1990 Recommendations of the International Commission on Radiological Protection. Annal. ICRP ***21*** (***1-3***). Pergamon Press, Oxford, 201pp. (ICRP Publ. (***60***)).

International Commission on Radiological Protection, 1993. Principles for intervention for protection of the public in a radiological emergency. Annal. ICRP ***22*** (***4***). Pergamon Press, Oxford, 30pp. (ICRP Publ. (***63***)).

International Commission on Radiological Protection, 1994. Age-dependent doses to members of the public from intake of radionuclides: Part 2 Ingestion dose coefficients. Annal. ICRP 23 (3/4). Pergamon Press, Oxford, 167pp. (ICRP Publ. (***67***)).

International Commission on Radiological Protection, 1995. Age-dependent doses to members of the public from intake of radionuclides: Part 3 Ingestion dose coefficients. Annal. ICRP 25(1). Pergamon Press, Oxford, 74pp. (ICRP Publ. (***69***))

Kershaw, P.J. and Baxter, A.J., 1995. The transfer of reprocessing wastes from north-west Europe to the Arctic. Deep-Sea Res. II, ***43*** (***6***) 1413-1448.

Kershaw, P.J., Pentreath, R.J., Woodhead, D.S. and Hunt, G.J., 1992. A review of radioactivity in the Irish Sea. Aquat. Environ. Monit. Rep., MAFF Direct. Fish. Res., Lowestoft, (***32***): 1-65.

Kocher, D.C. and Eckerman, K.F., 1987. Electron dose-rate conversion factors for external exposure of the skin from uniformly deposited activity on the body surface. Hlth. Phys., ***53***: 135-141.

Leonard, D.R.P., 1984. Investigation of individual radiation exposures: comparative use of interview and logging techniques in habits surveys of the Cumbrian coastal fishing community. Pp.763-766. *In*: A. Kaul, R. Neider, J. Pensko, F.-E. Stieve and H. Brunner (Eds.) 'Radiation-Risk-Protection, Vol. II. Proc. 6th Int. Congr. Int. Radiat. Prot. Assoc., Berlin'. Fachverband für Strahlenschutz e.V., Julich.

Leonard, D.R.P. and Hunt, G.J., 1985. A study of fish and shellfish consumers near Sellafield: assessment of the critical groups including consideration of children. J. Soc. Radiol. Prot., ***5***: 129-139.

Leonard, D.R.P., Hunt, G.J. and Jones, P.G.W., 1982. Investigation of individual radiation exposures from discharges to the aquatic environment: techniques used in habits surveys. pp. 512-517. *In*: 'Proc. 3rd Int. Symp. Soc. Radiol. Prot., Inverness, 2' Society of Radiological Protection.

Leonard, D.R.P., Camplin, W.C. and Tipple, J.R., 1990. The variability of radiocaesium concentrations in freshwater fish caught in the UK following the Chernobyl nuclear reactor accident: an assessment of potential doses to critical group consumers. pp. 247-256. *In*: 'Proc. Int. Symp. on Environmental Contamination Following a Major Nuclear Accident'. IAEA, Vienna, IAEA-SM-306/ ***15***.

McKay, W.A. *et al*., 1995. Site specific background dose rates in coastal areas. DoE/HMIP/RR/94/037. Her Majesty's Inspectorate of Pollution, London.

Ministry of Agriculture, Fisheries and Food, 1995. Terrestrial radioactivity monitoring programme (TRAMP) report for 1994. Radioactivity in food and agricultural products in England and Wales. MAFF, London, TRAMP/9, 223pp.

Ministry of Agriculture, Fisheries and Food, 1996. Removal of post-Chernobyl sheep controls in Cumbria. MAFF News Release, 15/96, London, 3pp 17 January 1996.

Mondon, K.J., and Walters, B., 1990. Measurements of radiocaesium, radiostrontium and plutonium in whole diets following deposition of radioactivity in the UK originators from the Chernobyl power plant accident. Food Additives and Contaminants. ***7 (6)***: 837-848.

Mudge, S.M., 1994. A survey of radioactivity in the Ribble Estuary II: Radiological assessment. Env. Series Rep. No. 3. Her Majesty's Inspectorate of Pollution, London.

National Radiological Protection Board, 1990. Gut transfer factors. Docs. NRPB ***1***(***2***). NRPB, Chilton, 26pp.

National Radiological Protection Board, 1993. Dose quantities for protection against external radiations. Docs. NRPB 4(3). NRPB, Chilton, 51pp.

Organisation for Economic Co-operation and Development, Nuclear Energy Agency, 1985. Review of the continued suitability of the dumping site for radioactive waste in the North-East Atlantic. OECD, Paris, 448pp.

OSPAR, 1993a. OSPAR Convention. *In*: Ministerial Meeting of the Oslo and Paris Commissions, Paris 21-22 Sept. 1992, Annex 1, pp75-112. Oslo and Paris Commissions, London.

OSPAR, 1993b. North-Sea quality status report. Oslo and Paris Commissions, London.

Pentreath, R.J., Camplin, W.C. and Allington, D.J., 1989. Individual and collective dose rates from naturally-occurring radionuclides in seafood. Pp. 297-300. *In*: E. P. Goldfinch (Ed.), 'Radiation Protection Theory and Practice, Proc. 4th Int. Symp. Soc. Radiol. Prot., Malvern, 4-9 June 1989'. Institute of Physics, Bristol and New York.

Phipps, A.W., Kendall, G.M., Stather, J.W. and Fell, T.P., 1991. Committed equivalent organ doses and committed effective doses from intakes of radionuclides. HMSO, London, 92pp (NRPB-R245).

Playford, K., Toole, J. and Sanders, T., 1995. Radioactive fallout in air and rain: results to the end of 1993. DOE/RAS/94.004. DOE, London.

Rollo, S.F.N., Camplin, W.C., Allington, D.J. and Young, A.K., 1992. Natural radionuclides in the UK marine environment. *In*: 'Proceedings of the Fifth International Symposium on Natural Radiation Environment, Saltzburg, September 22-28, 1991'. Radiat. Prot. Dosim., ***45***, 1/4: 203-210.

Rollo, S.F.N., Camplin, W.C., Duckett, L., Lovett, M.B. and Young, A.K., 1994. Airborne radioactivity in the Ribble Estuary. pp277-280. *In*: 'Proc. IRPB Regional Congress on Radiological Protection, 6-10 June 1994, Portsmouth, UK'. Nuclear Technology Publishing.

Scottish Office, 1996. Environmental monitoring for radioactivity in Scotland, 1989 to 1993. Env/1996/2. SO, Edinburgh, 78pp.

Simmonds, J.R., Lawson, G. and Mayall, A., 1995. Radiation Protection 72; Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment. Report EUR 15760 EN. Office for Official Publications of the European Community, Luxembourg.

Smith, D.M., Bulloch, K.A., Clark, I.E. and Gow, C., 1994a. Environmental radioactivity surveillance programme; results for 1992. NRPB-M457. National Radiological Protection Board, Chilton.

Spiers, F.W., Gibson, J.A.B. and Thompson, I.M.G., 1981. A guide to the measurement of environmental gamma-ray dose rate. National Physical Laboratory, Teddington, 107pp.

Stewart, T.H., Fulker, M.J. and Jones, S.R., 1990. A survey of habits of people living close to the Sellafield nuclear reprocessing plant. J. Radiol. Prot. 10, 115-122.

United Kingdom - Parliament, 1960. Radioactive Substances Act, 1960. HMSO, London, 28 pp.

United Kingdom - Parliament, 1965. Nuclear Installations Act, 1965. HMSO, London.

United Kingdom - Parliament, 1995a. Review of Radioactive Waste Management Policy. HMSO, London, 55pp. (Cm 2919).

United Kingdom - Parliament, 1993. Radioactive Substances Act, 1993. HMSO, London, 44pp.

United Kingdom - Parliament, 1995b. Environment Act, 1995. HMSO, London, 394pp.

Welsh Office. Press Release reference WO W96016 of 17 January 1996.

Wilkins, B.T., Simmonds, J.R. and Cooper, J.R., 1994. Assessment of the present and future implications of radioactive contamination of the Irish Sea coastal region of Cumbria. HMSO, London, 231pp. (NRPB-R267).

Table 1. Principal discharges of liquid radioactive waste from nuclear establishments in England and Wales, 1995

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995	
			TBq[a]	% of limit[b]
British Nuclear Fuels plc				
Sellafield[c] Sea pipelines	Alpha	1	0.397	40
	Beta	400	188	47
	Tritium	$1.8\ 10^{4}$	2670	15
	Carbon-14	20.8	12.4	60
	Cobalt-60	13	1.28	9.9
	Strontium-90	48	27.7	58
	Zirconium-95+Niobium-95	9	0.743	8.3
	Technetium-99	200	192	96
	Ruthenium-106	63	7.26	12
	Iodine-129	1.3	0.253	19
	Caesium-134	6.6	0.511	7.7
	Caesium-137	75	12.2	16
	Cerium-144	8	1.10	14
	Plutonium alpha	0.7	0.311	44
	Plutonium-241	27	7.69	18
	Americium-241	1.3	0.112	37
	Uranium[d]	2040	1345	66
Factory sewer	Alpha	0.0033	$4.3\ 10^{-5}$	1.3
	Beta	0.0135	$8.2\ 10^{-4}$	6.1
	Tritium	0.132	0.0179	14
Drigg Sea pipeline	Alpha	0.1	$9.22\ 10^{-4}$	<1
	Beta[e]	0.3	0.0219	7.3
	Tritium	120	2.70	2.3
Stream[f]	Alpha	$9.0\ 10^{4}$	65.9	<1
	Beta[e]	$1.2\ 10^{6}$	5720	<1
	Tritium	$6.0\ 10^{8}$	$2.6\ 10^{5}$	<1
Springfields	Alpha	4	0.115	2.9
	Beta	240	112	46
	Technetium-99	0.6	0.0301	5.0
	Thorium-230	2	0.0565	2.8
	Thorium-232	0.2	0.00159	<1
	Neptunium-237	0.04	$1.9\ 10^{-4}$	<1
	Uranium	0.15	0.0477	32
Capenhurst Rivacre Brook	Uranium	0.02	0.00181	9.1
	Uranium daughters	0.02	0.0068	34
	Non-uranic alpha	0.003	$1.01\ 10^{-4}$	3.4
	Technetium-99	0.1	0.00528	5.3
Meols outfall	Technetium-99	0.148	Nil	Nil
	Others	0.00148	"	"
United Kingdom Atomic Energy Authority				
Harwell (pipeline)	Alpha	0.001	$5.02\ 10^{-5}$	5.0
	Beta[e]	0.02	0.00357	18
	Tritium	4	0.0612	1.5
	Cobalt-60	0.007	$4.81\ 10^{-4}$	1.5
	Caesium-137	0.007	$4.04\ 10^{-4}$	5.8
Harwell (Lydebank Brook)	Alpha	$5\ 10^{-4}$	$4.59\ 10^{-5}$	9.2
	Beta[e]	0.002	$3.21\ 10^{-4}$	16
	Tritium	0.1	0.0302	30
Winfrith (inner pipeline)	Alpha	0.3	0.00186	<1
	Tritium	650	0.770	<1
	Cobalt-60	10	0.00181	<1
	Zinc-65	6	$1.51\ 10^{-4}$	<1
	Other radionuclides	80	0.0261	<1
Winfrith (outer pipeline)	Alpha	0.004	$1.54\ 10^{-4}$	3.8
	Tritium	1	0.0233	2.3
	Other radionuclides	0.01	$2.41\ 10^{-4}$	2.4
Nuclear Electric plc				
Berkeley	Tritium	8	0.0395	<1
	Caesium-137	0.2	0.0403	20
	Other radionuclides	0.4	0.0934	23
Bradwell	Tritium	30	2.08	6.9
	Caesium-137	0.75	0.366	49
	Other radionuclides	1	0.440	44

Table 1. continued

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995	
			TBq[a]	% of limit[b]
Dungeness				
'A' Station	Tritium	35	0.217	<1
	Caesium-137	1.2	0.508	42
	Other radionuclides	1.4	0.294	21
'B' Station	Tritium	650	15.1	2.3
	Sulphur-35	2	0.0203	1
	Cobalt-60	0.03	0.00259	8.6
	Other radionuclides	0.25	0.0249	9.9
Hartlepool[g]	Tritium	1850	139	13
	Sulphur-35	7.5	0.179	4.1
	Other radionuclides	4	0.00147	<1
	Tritium	1200	98.4	20
	Sulphur-35	3	0.176	14
	Cobalt-60	0.03	0.00300	24
	Other radionuclides	0.3	0.00184	1.5
Heysham				
Station 1[g]	Tritium	1850	131	12
	Sulphur-35	7.5	0.0574	1.3
	Other radionuclides	4	0.00459	<1
	Tritium	1200	120	24
	Sulphur-35	2.8	0.0552	4.7
	Cobalt-60	0.03	$4.57\ 10^{-4}$	3.7
	Other radionuclides	0.3	0.00241	1.9
Station 2[g]	Tritium	1200	214	31
	Sulphur-35	7	0.0433	1.1
	Cobalt-60	0.036	$5.57\ 10^{-4}$	2.7
	Other radionuclides	0.45	0.00355	1.4
	Tritium	1200	119	24
	Sulphur-35	2.3	0.0112	1.2
	Cobalt-60	0.03	$3.25\ 10^{-4}$	2.6
	Other radionuclides	0.3	0.00520	4.2
Hinkley Point				
'A' Station	Tritium	25	0.756	3.0
	Caesium-137	1.5	0.605	40
	Other radionuclides	1	0.376	38
'B' Station[h]	Tritium	650	81.5	50
	Sulphur-35	2	0.368	74
	Cobalt-60	0.035	$4.3\ 10^{-5}$	<1
	Other radionuclides	0.25	0.00235	3.8
	Tritium	620	350	75
	Sulphur-35	5	0.980	26
	Cobalt-60	0.033	$3.61\ 10^{-4}$	1.5
	Other radionuclides	0.235	0.0138	7.8
Oldbury	Tritium	25	0.232	1.0
	Caesium-137	0.7	0.048	6.8
	Other radionuclides	1.3	0.315	24
Sizewell				
'A' Station	Tritium	35	6.69	19
	Caesium-137	1.0	0.171	17
	Other radionuclides	0.7	0.223	32
'B' Station	Tritium	40	10.7	27
	Other radionuclides	0.2	0.0172	8.6
Trawsfynydd	Total activity[e,i,j]	0.72	0.0114	1.6
	Tritium	12	0.232	1.9
	Strontium-90	0.08	0.00198	2.5
	Caesium-137	0.05	0.0112	22
Wylfa	Tritium	40	7.56	19
	Other radionuclides	0.15	0.0528	35
Ministry of Defence				
Aldermaston (pipeline)[k]	Alpha	$1.5\ 10^{-4}$	$6.60\ 10^{-6}$	4.4
	Tritium	0.05	0.0104	21
	Plutonium-241	$6.0\ 10^{-4}$	$2.64\ 10^{-5}$	4.4
	Other radionuclides	$1.5\ 10^{-4}$	$6.13\ 10^{-6}$	4.1
Aldermaston (Silchester)[k]	Alpha	$1.0\ 10^{-4}$	$1.45\ 10^{-5}$	14
	Beta	$3.0\ 10^{-4}$	$5.86\ 10^{-5}$	20
Barrow[l]	Tritium	0.02	$4.90\ 10^{-4}$	2.5
	Manganese-54	$2.5\ 10^{-7}$	$5.57\ 10^{-9}$	2.2
	Cobalt-58	$7.0\ 10^{-7}$	$3.71\ 10^{-9}$	<1
	Cobalt-60	$7.0\ 10^{-8}$	$8.56\ 10^{-9}$	12
	Tin-113	$2.5\ 10^{-7}$	$6.47\ 10^{-9}$	2.6
	Antimony-124	$2.0\ 10^{-6}$	$3.99\ 10^{-9}$	<1
	Other radionuclides	$3.5\ 10^{-6}$	$1.03\ 10^{-8}$	<1

Table 1. continued

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995 TBq[a]	% of limit[b]
Burghfield[k]	Alpha	2.0 10^{-6}	2.13 10^{-8}	1.1
	Other radionuclides	1.2 10^{-5}	4.25 10^{-8}	<1
Devonport[m,n] (sewer)	Beta		Nil	
	Tritium		"	
	Cobalt-60		"	
Devonport[m,n] (river)	Beta		"	
	Tritium		"	
	Cobalt		"	
Devonport[n,o] (sewer)	Total activity		6.13 10^{-4}	
	Cobalt-60		5.20 10^{-4}	
Devonport[o] (pipeline)	Total activity[e,p]	0.002	3.91 10^{-5}	2.0
	Tritium	0.12	0.0603	50
	Cobalt-60	0.016	1.35 10^{-4}	<1
Greenwich	Beta		2.4 10^{-6}	
Amersham International plc				
Amersham	Alpha	3.0 10^{-4}	5.32 10^{-5}	18
	Beta >0.4 MeV	0.1	0.00936	9.4
	Tritium	0.2	0.00983	4.9
	Iodine-125	0.2	0.00117	<1
	Caesium-137	0.005	1.38 10^{-5}	<1
	Other radionuclides	0.3	0.164	55
Cardiff[q]	Beta/gamma[r]	0.096	0.00208	13
	Tritium	1400	79	34
	Carbon-14	2	0.162	49
	Tritium	900	379	51
	Carbon-14	2	1.09	65
	Phosphorus-32/33	0.01	7.3 10^{-5}	<1
	Iodine-125	0.05	0.0145	35
	Others	5.0 10^{-4}	1.8 10^{-4}	46
Imperial College Reactor Centre				
Ascot	Tritium	1.0 10^{-4}	8.71 10^{-6}	9
	Other radioactivity	4.0 10^{-5}	3.64 10^{-6}	9
Imperial Chemical Industries plc				
Billingham	Beta/gamma	0.36	4.06 10^{-5}	<1
Rolls Royce plc				
Derby	Alpha	0.00666	3.39 10^{-4}	5.1
Universities Research Reactor Centre				
Risley[s]	Alpha		9.36 10^{-9}	
	Beta		5.72 10^{-7}	

[a] *Some discharges are upper estimates because they include 'less than' data derived from analyses of effluents at limits of detection. Data quoted to 3 significant figures except where fewer significant figures are provided in source documents*
[b] *Data quoted to 2 significant figures except when values are less than 1%*
[c] *New limits came into effect from 1 January 1995 for total alpha, strontium-90, zirconium-95+niobium-95, ruthenium-106, cerium-144, plutonium alpha and plutonium-241*
[d] *The limit and discharge data are expressed in kg*
[e] *Excluding tritium*
[f] *Discharges and limits are expressed in terms of concentrations of activity in Bq m^{-3}*
[g] *Authorisation was revised with effect from August 1995. The first block of data relates to the period 1 January 1995 to 31 July 1995; the second block of data relates to the period 1 August 1995 to 31 December 1995. '% limit' refers to equivalent limit for 7 and 5 months respectively*
[h] *Authorisation was revised with effect from 1 April 1995. The first block of data relates to the period 1 January 1995 to 31 March 1995: the second block of data relates to the period 1 April 1995 to 31 December 1995. '% limit' refers to equivalent limit for 3 and 9 months respectively*
[i] *Excluding caesium-137*
[j] *Excluding strontium-90*
[k] *Discharges are made by Hunting-BRAE Ltd*
[l] *Discharges from Barrow are included with those from MoD sites because they are related to submarine activities. Discharges are made by Vickers Shipbuilding and Engineering Ltd*
[m] *Discharges are made by the Ministry of Defence*
[n] *The authorisation includes a limit on concentration of total activity of 4 10^{-6} TBq m^{-3}. At no time did the concentration exceed the limit*
[o] *Discharges are made by Devonport Management Ltd*
[p] *Excluding cobalt-60*
[q] *Authorisation was revised with effect from 1 March 1995. The first block of data relates to the period 1 January 1995 to 28 February 1995: the second block of data relates to the period 1 March 1995 to 31 December 1995. '% limit' refers to equivalent limit for 2 and 10 months respectively*
[r] *Excluding tritium, carbon-14 and radioisotopes of calcium and strontium*
[s] *The authorisation includes limits on concentrations of alpha and beta activity of 1.11 10^{-7} and 3.7 10^{-6} TBq m^{-3} respectively. At no time did the concentrations exceed the limits*

Table 2. Principal discharges of gaseous radioactive wastes from nuclear establishments in England and Wales, 1995

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995	
			TBq	% of limit
British Nuclear Fuels plc				
Sellafield[a,b]	Alpha	0.0017	$1.53\ 10^{-4}$	9.0
	Beta	0.048	0.00536	11
	Tritium	1400	590	42
	Carbon-14	8.4	0.71	8.5
	Sulphur-35	0.21	0.14	67
	Argon-41	3700	2400	65
	Cobalt-60	$9.2\ 10^{-4}$	$5.5\ 10^{-5}$	6.0
	Krypton-85	$3.5\ 10^{5}$	$9.7\ 10^{4}$	28
	Strontium-90	0.0016	$9.5\ 10^{-5}$	5.9
	Ruthenium-106	0.046	$8.0\ 10^{-4}$	1.7
	Antomony-125	0.005	0.001	20
	Iodine-129	0.067	0.020	30
	Iodine-131	0.055	0.0012	2.2
	Caesium-137	0.0073	$6.1\ 10^{-4}$	8.4
	Plutonium (alpha)	$8.4\ 10^{-4}$	$5.3\ 10^{-5}$	6.3
	Plutonium-241	0.0051	$7.6\ 10^{-4}$	15
	Americium-241 and curium-242	$3.6\ 10^{-4}$	$3.8\ 10^{-5}$	11
Springfields[c]	Alpha	[d]	$6.63\ 10^{-4}$	
	Uranium	0.006	$9.46\ 10^{-5}$	9.5
Capenhurst	Uranium	$1.0\ 10^{-4}$	$5.04\ 10^{-6}$	5.0
United Kingdom Atomic Energy Authority				
Harwell	Alpha	$7.0\ 10^{-6}$	$2.1\ 10^{-7}$	3.0
	Beta	$4.5\ 10^{-4}$	$6.3\ 10^{-6}$	1.4
	Tritium	150	8.43	5.6
Windscale	Alpha	$1.2\ 10^{-5}$	$2.25\ 10^{-7}$	1.9
	Beta	0.005	$6.98\ 10^{-6}$	< 1
	Tritium	2.3	0.0376	1.6
	Krypton-85	14	0.202	1.4
	Iodine-131	0.0012	$7.23\ 10^{-6}$	<1
Winfrith	Alpha	$2.0\ 10^{-6}$	$6.0\ 10^{-9}$	<1
	Beta	$2.5\ 10^{-5}$	$1.8\ 10^{-8}$	<1
	Tritium	15	12.0	80
	Carbon-14	0.3	$4.8\ 10^{-4}$	<1
	Krypton-85	150	0.061	<1
Nuclear Electric plc[e]				
Berkeley				
Technology Centre	Alpha and beta	$2.0\ 10^{-5}$	$2.0\ 10^{-6}$	10
Power Station and Technology Centre	Alpha and beta	$2.0\ 10^{-4}$	$2.10\ 10^{-6}$	1.1
	Tritium	2	0.0109	<1
	Carbon-14	0.2	$5.26\ 10^{-4}$	<1
	Sulphur-35	0.006	$6.47\ 10^{-8}$	<1
Bradwell	Beta	0.001	$1.56\ 10^{-4}$	16
	Tritium	1.5	1.27	85
	Sulphur-35	0.2	0.0427	21
	Carbon-14	0.6	0.363	61
	Argon-41	1000	662	66
Dungeness				
'A' Station	Beta	0.001	$3.8\ 10^{-4}$	38
	Tritium	2	0.62	31
	Carbon-14	5	3.6	72
	Sulphur-35	0.4	0.093	23
	Argon-41	2000	1200	60
'B' Station	Beta	0.001	$1.2\ 10^{-5}$	1.2
	Tritium	15	2.4	16
	Carbon-14	5	0.16	3.2
	Sulphur-35	0.45	0.0074	1.6
	Argon-41	150	6.9	4.6
	Iodine-131	0.005	$3.3\ 10^{-6}$	<1
Hartlepool[f]	Sulphur-35	7.5	0.0166	<1
	Argon-41	750	6.9	<1
	Iodine-131	0.5	$1.0\ 10^{-4}$	<1
	Beta	0.001	$1.46\ 10^{-5}$	1.5
	Tritium	6	0.426	7.1
	Carbon-14	5	0.452	9.0
	Sulphur-35	0.16	0.0131	8.2
	Argon-41	60	3.73	6.2
	Iodine-131	0.005	$9.17\ 10^{-5}$	1.8

Table 2. continued

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995 TBq	% of limit
Heysham[g]				
Station 1	Sulphur-35	7.5	0.00916	<1
	Argon-41	750	11.8	1.6
	Iodine-131	0.5	7.16 10^{-4}	1.4
	Beta	0.001	1.99 10^{-5}	4.8
	Tritium	6	0.72	29
	Carbon-14	4	0.37	22
	Sulphur-35	0.12	0.00753	15
	Argon-41	60	15.3	61
	Iodine-131	0.005	5.0 10^{-4}	24
Station 2	Beta	0.006	1.73 10^{-5}	<1
	Tritium	36	1.11	5.3
	Carbon-14	4	0.569	24
	Sulphur-35	1.8	0.00538	<1
	Argon-41	300	13.9	7.9
	Iodine-131	0.005	1.76 10^{-4}	6.0
	Beta	0.001	9.6 10^{-6}	2.3
	Tritium	15	1.0	16
	Carbon-14	3	0.34	27
	Sulphur-35	0.3	0.0051	4.1
	Argon-41	85	8.6	24
	Iodine-131	0.005	1.1 10^{-4}	5.3
Hinkley Point				
'A' Station	Beta	0.001	1.57 10^{-4}	16
	Tritium	25	2.62	10
	Carbon-14	4	1.06	26
	Sulphur-35	0.2	0.0973	49
	Argon-41	4500	3200	71
'B' Station	Beta	0.001	7.68 10^{-5}	7.7
	Tritium	30	2.46	8.2
	Carbon-14	8	0.843	11
	Sulphur-35	0.4	0.0991	25
	Argon-41	300	41.8	14
	Iodine-131	0.005	1.95 10^{-5}	<1
Oldbury	Beta	0.001	1.01 10^{-4}	10
	Tritium	5	1.89	38
	Carbon-14	6	3.75	63
	Sulphur-35	0.8	0.261	35
	Argon-41	500	250	50
Sizewell				
'A' Station	Beta	0.001	3.43 10^{-4}	34
	Tritium	7	1.33	19
	Carbon-14	1.5	0.91	61
	Sulphur-35	0.6	0.185	31
	Argon-41	3000	1950	65
'B' Station (outlets 1-3)	Nobel gases	295	4.15	1.4
	Halogens	0.0027	8.0 10^{-5}	3.0
	Beta	0.01	1.92 10^{-5}	0.2
	Tritium	7.8	0.141	1.8
	Carbon-14	0.59	0.0123	2.1
" (Approved places)	Nobel gases	5	Nil	Nil
	Halogens	3.0 10^{-4}	"	"
	Tritium	0.2	0.003	1.5
	Carbon-14	0.01	Nil	Nil
Trawsfynydd	Beta	0.002	3.09 10^{-6}	<1
	Tritium	10	0.156	1.6
	Carbon-14	5	0.00102	<1
	Sulphur-35	0.4	4.6 10^{-4}	<1
	Argon-41	350	Nil	Nil
Wylfa	Beta	0.001	9.99 10^{-5}	10
	Tritium	20	10.3	52
	Carbon-14	2.4	1.15	48
	Sulphur-35	0.5	0.259	52
	Argon-41	120	19.2	16
Ministry of Defence				
Aldermaston[a]	Alpha	9.0 10^{-7}	1.29 10^{-7}	14
	Beta[h]	4.6 10^{-6}	1.21 10^{-7}	2.6
	Tritium	340	4.47	1.3
	Krypton-85	0.4	4.8 10^{-3}	1.2
Barrow[i]	Tritium	3.2 10^{-6}	Nil	
	Argon-41	0.08	"	
Burghfield[a]	Alpha	2.0 10^{-8}	6.4 10^{-10}	3
	Tritium	0.35	1.24 10^{-4}	< 1
	Krypton-85	1	0.0082	< 1
Greenwich[d]	Argon-41		0.057	

Table 2. continued

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995	
			TBq	% of limit
Amersham International plc				
Amersham	Alpha	2.0 10^{-6}	6.1 10^{-7}	31
	Other (penetrating)	0.05	1.7 10^{-4}	<1
	Other (non-penetrating)	0.5	0.018	3.6
	Tritium	40	0.18	<1
	Selenium-75	0.03	0.0011	11
	Iodine-131	0.05	0.0044	8.8
	Radon-222	10	1.6	16
Cardiff[j]	Soluble tritium	1000	30.3	18
	Soluble carbon-14	10	0.37	22
	Iodine-125	0.1	0.0017	7.0
	Soluble tritium	400	149	45
	Insoluble tritium	1000	359	43
	Carbon-14	6	3.28	66
	Phosphorus-32/33	2.0 10^{-4}	7.93 10^{-5}	48
	Iodine-125	5.0 10^{-4}	9.67 10^{-5}	23
	Other activity	0.04	1.9 10^{-4}	<1
Imperial College Reactor Centre				
Ascot	Tritium	5.0 10^{-4}	1.89 10^{-4}	38
	Argon-41	2.5	0.928	37
Imperial Chemical Industries plc				
Billingham	Tritium	2	0.098	4.9
	Argon-41	2	8.4 10^{-6}	<1
Johnson and Johnson Clinical Diagnostics Ltd[k]				
Cardiff	Iodine-125	0.015	0.0044	39
	Other activity	5.0 10^{-4}	2.9 10^{-5}	7.7
Rolls Royce plc				
Derby	Alpha	[d]	1.0 10^{-6}	
University Research Reactor Centre				
Risley	Argon-41	[d]	2.0 10^{-9}	
URENCO				
Capenhurst	Uranium	2.5 10^{-6}	2.7 10^{-8}	1.1

[a] *Discharge limits and discharges are aggregated from data for individual locations on the site. Percentages are given as a general guide to usage of the limits but should strictly be calculated for individual locations. All discharges were below the appropriate limit for each location.*
[b] *Some limits are related to the operation of the THORP plant and may thus vary from year to year*
[c] *Authorisation was revised with effect from 1 November 1995. The first row of data relates to the period 1 January 1995 to 31 October 1995; the second row relates to the period 1 November 1995 to 31 December 1995. '% limit' refers to the equivalent limit for 2 months*
[d] *There are no numerical limits for this discharge. However, the authorisation stipulates that the Best Practicable Means should be used to control the discharge*
[e] *Discharges are also authorised from incinerators at Nuclear Electric sites*
[f] *Authorisation was revised with effect from 15 August 1995. The first block of data relates to the period 1 January 1995 to 31 July 1995; the second block of data relates to the period 1 August 1995 to 31 December 1995. '% limit' refers to equivalent limit for 7 and 5 months respectively*
[g] *Authorisations were revised with effect from 10 August 1995. For each station, the first block of data relates to the period 1 January 1995 to 31 July 1995; the second block of data relates to the period 1 August 1995 to 31 December 1995. '% limit' refers to equivalent limit for 7 and 5 months respectively*
[h] *Excluding tritium and plutonium-241*
[i] *Discharges from Barrow are included with those from MoD sites because they are related to submarine activities. Discharges are made by Vickers Shipbuilding and Engineering Ltd*
[j] *Authorisation was revised with effect from 1 March 1995. The first block of data relates to the period 1 January 1995 to 28 February 1995; the second block of data relates to the period 1 March 1995 to 31 December 1995. '% limit' refers to the equivalent limit for 2 and 10 months respectively*
[k] *Authorisation took effect from 27 March 1995. '% limit' refers to the equivalent limit for 9 months*

Table 3. Disposals of solid radioactive waste to Drigg, 1995

Radioactivity	Disposal limit, TBq	Disposals during 1995	
		TBq	% of limit
Tritium	10	0.191	1.9
Carbon-14	0.05	0.00735	15
Cobalt-60	2	0.297	15
Iodine-129	0.05	0.00169	3.4
Radium-226 plus thorium-232	0.03	0.00356	12
Uranium	0.3	0.0214	7.1
Other alpha[a]	0.3	0.0836	28
Others[a,b]	15	4.22	28

[a] *With half-lives greater than three months*
[b] *Other beta emitting radionuclides but including iron-55 and cobalt-60*

Table 4. Scope of the monitoring programmes

Programme	Sub-programme	Main purpose
Nuclear sites[a]	-	Support for RSA 93, assessment of waste disposal
	Grass and soil	Support for EURATOM Treaty
Industrial sites[b]	Chemical works	Support for RSA 93, assessment of waste disposal
	Landfill sites	"
Chernobyl fallout	Sheep monitoring guidance on restrictions	Support for FEPA 85,
	Freshwater fish	Support for FEPA 85, trend analysis
Regional[b]	Milk and crops	General food safety
	Diet	"
	Isle of Man	"
	Northern Ireland	"
	Channel Islands	"
	Seawater	Support for OSPAR Convention

[a] *The terrestrial parts of this programme, excluding most grass and soil sampling and all drycloth sampling, are known as TRAMP (Terrestrial Radioactivity Monitoring Programme)*
[b] *The terrestrial parts of these programmes are known as FARM (Food and Agriculture Monitoring Programme)*

Table 5. Scope of the nuclear site sampling in 1995*

Measurement	Frequency of measurement	Analyses	Types of material or measurements	Detailed species/materials
Aquatic programme				
Analysis of foods	Annually to monthly	Total beta, gamma spectrometry, ^{3}H, ^{14}C, ^{35}S, ^{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, whitebait, fish oil, salmon, sole, spurdog, saithe, mackerel, haddock, crabs, lobsters, winkles, native oysters, mussels, limpets, whelks, cockles, *Nephrops*, pacific oysters, shrimps, squid, scallops, queens, *Porphyra* laverbread, samphire, pike, elvers, brown trout, rainbow trout, perch and spider crabs
Analysis of indicator materials	Annually to weekly	“	Water, sediments, salt marsh, seaweeds, aquatic plants and coarse fish	Fish meal, mud, sand, coal, clay, salt marsh, peat, turf, seawater, freshwater, *Fucus spp., Rhodymenia spp., Fontinalis, Cladophoraceae spp., Elodia canadensis, Nupha lutea,* rudd
Gamma dose rates	Annually to monthly	-	On beaches, harbours, marshes riverbanks, lakesides and boats	-
Beta dose rates	Annually to quarterly	-	On nets, pots, sediments and saltmarsh	
Contamination survey	Annually to monthly	-	On beaches	-
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, ^{90}Sr, ^{99}Tc, Ru, ^{131}I, ^{129}I, ^{147}Pm, Cs, ^{210}Po, U, transuranics	Milk, crops and animals	Cows’ and goats’ milk, beef meat, kidney and liver, sheep meat and offal, geese, eggs, hares, duck, rabbits, honey, mushrooms, hazelnuts, oats, wheat, barley, rhubarb, elderberries, sloes, damsons, apples, blackberries, strawberries, raspberries, cabbage, sea kale, lettuce, potatoes, green and runner beans, turnips, leeks, carrots, swede, sprouts, celery, spinach, peas and cauliflower
Analysis of indicator materials	Annually to monthly	“	Grass, soil, faeces, dry cloths and animal food	Grass, soil, silage, animal faeces, rape, fodder beet, lucerne and dry cloths

* *The frequency of measurement, the types of analysis and the materials sampled vary from site to site. Not all analyses are carried out on all materials. Detailed information on the scope of the programme at individual sites is given in the tables of results. The information in this table is for the programme related to nuclear sites in England and Wales. The routine programme is supplemented by additional monitoring when necessary, for example in relation to site incidents. The results of such monitoring are included in this report*

Table 6. Analytical methods

Radionuclides	Sample type	Method of measurement
^{3}H ^{3}H (organic) ^{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	All	"
Beta	Dry cloths	"
Beta	Aquatic samples	"
$^{103+106}Ru$ ^{131}I ^{144}Ce $^{134+137}Cs$	Terrestrial samples	"
^{125}I ^{129}I	Terrestrial samples	Gamma counting by solid scintillation
^{134}Cs ^{137}Cs	Seawater	"
Gamma	Dry cloths	"
^{51}Cr ^{54}Mn ^{57}Co ^{58}Co ^{60}Co ^{59}Fe ^{65}Zn ^{95}Nb ^{95}Zr ^{110m}Ag ^{125}Sb ^{134}Cs ^{137}Cs ^{144}Ce ^{154}Eu ^{155}Eu ^{241}Am ^{233}Pa ^{234}Th	All	Gamma spectrometry using germanium detectors
^{129}I ^{131}I	Aquatic samples	"
U	Terrestrial samples	Activation and delayed neutron counting
^{210}Po ^{226}Ra ^{234}U $^{235+236}U$ ^{238}U ^{237}Np ^{228}Th ^{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	"

Table 7. Beta/gamma radioactivity in fish from the Irish Sea vicinity and further afield, 1995

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}							
			^{14}C	^{60}Co	^{90}Sr	^{99}Tc	^{134}Cs	^{137}Cs	^{147}Pm	Total beta
Sellafield coastal area	Cod	8	-	*	-	-	0.11 ±*0.12*	17 ±*0.5*	-	190
"	Plaice	4	-	*	-	-	0.06 ±*0.08*	17 ±*0.6*	-	190
"	Grey mullet	1	-	*	-	-	*	23 ±*0.3*	-	-
"	Bass	1	-	*	-	-	*	33 ±*0.7*	-	-
Sellafield offshore area	Cod	1	87 ±*8.3*	*	0.10 ±*0.01*	4.6 ±*0.4*	*	14 ±*0.5*	-	-
"	Plaice	1	110 ±*8.2*	0.09 ±*0.06*	0.11 ±*0.01*	23 ±*1.8*	0.08 ±*0.07*	11 ±*0.2*	*	-
"	Dab	1	-	*	-	-	*	13 ±*0.3*	-	-
Ravenglass	Cod	8	-	*	-	-	0.05 ±*0.07*	14 ±*0.4*	-	-
"	Plaice	8	-	0.02 ±*0.03*	-	-	0.01 ±*0.03*	9.9 ±*0.4*	-	-
"	Salmon	1	-	*	-	-	*	0.33 ±*0.11*	-	-
Whitehaven	Cod	4	53 ±*7.8*	*	0.051 ±*0.003*	-	*	5.4 ±*0.2*	-	-
"	Plaice	4	-	*	0.047 ±*0.005*	-	*	7.3 ±*0.3*	-	-
"	Ray	4	-	*	-	-	*	7.5 ±*0.3*	-	-
Parton	Cod	4	-	*	-	-	0.08 ±*0.08*	17 ±*0.4*	-	-
Morecambe Bay (Flookburgh)	Flounder	4	87 ±*8.8*	*	-	-	0.02 ±*0.03*	32 ±*0.7*	-	-
" (Morecambe)	Plaice	5	-	*	-	-	0.03 ±*0.06*	10 ±*0.3*	-	-
" "	Bass	2	-	*	-	-	*	29 ±*0.4*	-	-
" (Sunderland Point)	Whitebait	1	-	*	0.15 ±*0.03*	-	*	8.4 ±*0.2*	-	-
River Derwent	Sea trout	1	-	*	-	-	*	7.1 ±*0.3*	-	-
River Ehen	"	1	-	*	-	-	*	3.6 ±*0.2*	-	-
River Calder	"	1	-	*	-	-	*	2.2 ±*0.3*	-	-
Calder Farm	Rainbow trout	1	-	*	-	-	*	480 ±*7.5*	-	-
Fleetwood	Cod	4	57 ±*7.5*	*	-	-	*	8.8 ±*0.2*	-	-
"	Plaice	4	-	*	-	-	0.01 ±*0.03*	8.8 ±*0.2*	-	-
"	Fish meal[c]	4	-	*	0.20 ±*0.02*	-	*	1.7 ±*0.3*	-	-
"	Fish oil[c]	4	-	*	-	-	*	*	-	-
Isle of Man	Cod	4	-	*	-	-	*	3.6 ±*0.2*	-	-
"	Plaice	4	36 ±*8.3*	*	-	-	*	2.6 ±*0.2*	-	-
"	Herring	3	-	*	-	-	*	2.4 ±0.1	-	-
Inner Solway	Flounder	4	50 ±*8.3*	*	0.042 ±*0.003*	1.0 ±*0.1*	*	28 ±*0.8*	-	-
"	Sea trout	1	-	*	-	-	*	3.3 ±*0.5*	-	-
"	Salmon	1	-	*	-	-	*	0.85 ±*0.17*	-	-
Kirkcudbright	Plaice	2	-	*	-	-	*	5.0 ±*0.3*	-	-
North Anglesey	Ray	4	-	*	-	-	*	2.0 ±*0.1*	-	-
"	Plaice	2	31 ±*9.1*	*	-	-	*	1.8 ±*0.1*	-	-
Ribble Estuary	Flounder	1	-	*	-	-	*	12 ±*0.3*	-	-
"	Salmon	1	-	*	-	-	*	0.57 ±*0.23*	-	-
"	Sea trout	1	-	*	-	-	*	3.6 ±*0.2*	-	-

Table 7. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}							
			^{14}C	^{60}Co	^{90}Sr	^{99}Tc	^{134}Cs	^{137}Cs	^{147}Pm	Total beta
Northern Ireland	Cod	7	22 *±6.8*	*	-	-	*	4.0 *±0.1*	-	-
"	Whiting	6	-	*	-	-	*	5.2 *±0.1*	-	-
"	Herring	1	-	*	-	-	*	1.4 *±0.2*	-	-
"	Spurdog	8	-	*	-	-	*	4.0 *±0.4*	-	-
"	Saithe	4	-	*	-	-	*	7.3 *±0.3*	-	-
Sound of Mull	Salmon	1	-	*	-	-	*	1.8 *±0.1*	-	-
Minch	Cod	4	-	*	-	-	*	1.2 *±0.1*	-	-
"	Plaice	4	-	*	-	-	*	0.75 *±0.07*	-	-
"	Mackerel	2	43 *±15*	*	0.015 *±0.003*	-	*	0.29 *±0.16*	-	-
"	Haddock	4	-	*	-	-	*	0.73 *±0.09*	-	-
"	Herring	3	-	*	-	-	*	0.44 *±0.11*	-	-
Shetland	Fish meal[c]	4	-	*	0.032 *±0.002*	-	*	0.95 *±0.45*	-	-
"	Fish oil[c]	4	-	*	-	-	*	*	-	-
Northern North Sea	Cod	3	-	*	0.011 *±0.001*	-	*	0.56 *±0.09*	-	-
"	Plaice	3	-	*	-	-	*	0.72 *±0.08*	-	-
"	Herring	3	-	*	-	-	*	0.50 *±0.12*	-	-
"	Haddock	3	32 *±8.0*	*	-	-	*	0.41 *±0.07*	-	-
Mid-North Sea	Cod	4	-	*	0.015 *±0.001*	-	*	0.75 *±0.08*	-	-
"	Plaice	4	24 *±8.4*	*	0.0094 *±0.0011*	-	*	0.45 *±0.09*	-	-
"	Herring	3	-	*	-	-	*	0.71 *±0.13*	-	-
Southern North Sea	Cod	2	-	*	0.0079 *±0.0011*	-	*	0.51 *±0.09*	-	-
"	Plaice	2	-	*	0.0063 *±0.0010*	-	*	0.31 *±0.07*	-	-
"	Herring	2	-	*	-	-	*	0.69 *±0.15*	-	-
English Channel	Cod	2	-	*	0.023 *±0.002*	-	*	0.52 *±0.11*	-	-
"	Plaice	2	-	*	0.021 *±0.002*	-	*	0.30 *±0.06*	-	-
"	Mackerel	3	-	*	-	-	*	0.37 *±0.10*	-	-
Skagerrak	Cod	3	-	*	-	-	0.02 *±0.03*	0.76 *±0.07*	-	-
"	Herring	2	-	*	-	-	*	1.3 *±0.1*	-	-
Norwegian Sea	Cod	1	-	*	-	-	*	0.32 *±0.06*	-	-
Iceland area	"	1	-	*	-	-	*	0.26 *±0.05*	-	-
Icelandic processed	"	1	16 *±7.0*	*	-	-	*	0.32 *±0.08*	-	-
Barents Sea	"	4	-	*	-	-	*	0.47 *±0.07*	-	-
Baltic Sea	"	2	-	*	-	-	0.41 *±0.14*	16 *±0.3*	-	-
"	Herring	3	-	*	-	-	0.22 *±0.09*	7.1 *±0.2*	-	-

- *not analysed*
* *not detected by the method used*
[a] *Sampling area or landing point*
[b] *See section 5 for definition*
[c] *Concentrations refer to weight of sample as supplied*

Table 8. Beta/gamma radioactivity in shellfish from the Irish Sea vicinity and further afield, 1995

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}								
			^{14}C	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr	^{95}Nb	^{99}Tc	^{103}Ru	^{106}Ru
Sellafield coastal area	Crabs	8	140 ±*11*	1.1 ±*0.2*	*	7.4 ±*0.2*	*	*	140 ±*14*	*	1.2 ±*0.9*
"	Lobsters	8	190 ±*11*	1.1 ±*0.2*	*	0.75 ±*0.04*	*	*	8300 ±*700*	*	1.9 ±*1.8*
"	Winkles[c]	4	140 ±*10*	4.6 ±*0.4*	*	3.6 ±*0.1*	*	*	890 ±*70*	*	35 ±*3.9*
"	Mussels[c]	4	-	2.8 ±*0.2*	*	2.6 ±*0.1*	*	*	-	*	18 ±*1.6*
"	Limpets[c]	4	90 ±*11*	2.8 ±*0.3*	*	10 ±*0.3*	*	*	2300 ±*180*	*	28 ±*2.9*
"	Whelks	2	-	2.0 ±*0.2*	0.14 ±*0.19*	-	*	*	-	*	9.0 ±*2.7*
St Bees	Winkles	4	140 ±*9.3*	5.9 ±*0.2*	*	8.5 ±*0.3*	*	*	490 ±*38*	0.14 ±*0.15*	37 ±*1.8*
"	Mussels	4	-	3.1 ±*0.2*	*	-	0.12 ±*0.09*	0.25 ±*0.11*	-	0.14 ±*0.09*	34 ±*2.0*
"	Limpets	4	-	1.9 ±*0.2*	*	-	*	*	-	*	20 ±*2.1*
Nethertown	Winkles	12	170 ±*10*	9.2 ±*0.4*	*	10 ±*0.3*	0.22 ±*0.22*	0.29 ±*0.39*	1600 ±*140*	0.05 ±*0.06*	44 ±*3.4*
"	Mussels	4	290 ±*11*	4.5 ±*0.2*	*	-	0.14 ±*0.12*	0.37 ±*0.12*	360 ±*34*	0.16 ±*0.10*	45 ±*1.7*
Whitriggs	Shrimps	1	-	1.2 ±*0.2*	*	-	*	*	-	*	3.0 ±*2.0*
Drigg	Winkles	4	230 ±*10*	12 ±*0.5*	*	-	0.20 ±*0.30*	0.33 ±*0.46*	2600 ±*250*	*	71 ±*4.6*
Ravenglass	Mussels	4	-	3.9 ±*0.2*	*	-	*	*	380 ±*30*	0.05 ±*0.05*	28 ±*1.8*
"	Cockles	5	250 ±*9.5*	6.7 ±*0.3*	*	2.0 ±*0.1*	0.06 ±*0.07*	0.05 ±*0.07*	98 ±*8.6*	0.08 ±*0.12*	20 ±*1.9*
"	Crabs	4	-	0.43 ±*0.16*	*	1.0 ±*0.1*	*	*	25 ±*2.1*	*	0.73 ±*0.97*
"	Lobsters	4	-	0.66 ±*0.19*	*	0.42 ±*0.02*	*	*	4600 ±*410*	*	*
Tarn Bay	Winkles	4	-	5.7 ±*0.3*	*	-	0.17 ±*0.22*	0.36 ±*0.27*	-	0.17 ±*0.13*	45 ±*2.8*
Saltom Bay	"	4	-	2.6 ±*0.2*	*	-	*	*	-	*	10 ±*1.8*
Whitehaven	*Nephrops*	4	67 ±*7.6*	*	*	0.14 ±*0.03*	*	*	620 ±*53*	*	*
Parton	Winkles	4	-	2.7 ±*0.3*	*	-	*	*	-	*	11 ±*2.3*
"	Crabs	4	-	0.47 ±*0.24*	*	-	*	*	-	*	*
"	Lobsters	4	-	0.14 ±*0.10*	*	-	*	*	-	*	*
Haverigg	Cockles	2	-	3.4 ±*0.2*	*	-	*	*	-	*	9.3 ±*1.4*
Millom	Mussels	2	-	1.3 ±*0.2*	*	-	*	*	-	*	6.3 ±*1.3*
Roosebeck	Pacific oysters	4	-	0.39 ±*0.10*	*	-	*	*	-	*	0.94 ±*0.47*
Morecambe Bay (Flookburgh)	Shrimps	4	110 ±*10*	*	*	0.12 ±*0.02*	*	*	21 ±*1.7*	*	*
" (Morecambe)	Mussels	4	110 ±*9*	0.44 ±*0.08*	*	-	*	*	250 ±*20*	*	1.6 ±*0.6*

Table 8. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}							
			^{110m}Ag	^{125}Sb	^{134}Cs	^{137}Cs	^{144}Ce	^{147}Pm	^{154}Eu	^{155}Eu	Total beta
Sellafield coastal area	Crabs	8	8.3 *±0.5*	0.09 *±0.20*	*	3.6 *±0.2*	0.04 *±0.07*	0.46 *±0.02*	0.01 *±0.02*	*	210
"	Lobsters	8	15 *±0.7*	0.05 *±0.11*	*	5.5 *±0.2*	*	1.0 *±0.04*	*	*	6100
"	Winkles[c]	4	14 *±0.7*	1.9 *±0.7*	*	21 *±0.5*	0.57 *±0.63*	1.7 *±0.1*	0.33 *±0.28*	*	-
"	Mussels[c]	4	*	1.6 *±0.4*	*	4.7 *±0.2*	0.32 *±0.36*	-	0.45 *±0.24*	0.13 *±0.16*	-
"	Limpets[c]	4	19 *±0.7*	6.5 *±0.9*	*	22 *±0.4*	1.1 *±0.9*	-	0.58 *±0.36*	*	-
"	Whelks	2	31 *±0.8*	0.53 *±0.56*	*	2.3 *±0.2*	*	-	*	*	-
St Bees	Winkles	4	29 *±0.5*	2.5 *±0.4*	*	18 *±0.2*	1.0 *±0.4*	2.5 *±0.1*	0.45 *±0.24*	0.27 *±0.15*	-
"	Mussels	4	1.3 *±0.3*	2.0 *±0.4*	*	4.4 *±0.2*	0.85 *±0.59*	-	0.22 *±0.18*	*	-
"	Limpets	4	15 *±0.5*	3.7 *±0.7*	*	17 *±0.3*	0.59 *±0.40*	-	0.21 *±0.14*	0.29 *±0.23*	-
Nethertown	Winkles	12	31 *±0.9*	2.3 *±0.7*	*	21 *±0.4*	1.6 *±0.8*	3.3 *±0.1*	0.53 *±0.35*	0.11 *±0.17*	1700
"	Mussels	4	0.90 *±0.21*	2.3 *±0.4*	*	5.6 *±0.2*	1.3 *±0.5*	-	0.43 *±0.30*	0.12 *±0.14*	470
Whitriggs	Shrimps	1	1.4 *±0.4*	*	0.48 *±0.17*	17 *±0.3*	*	-	*	*	-
Drigg	Winkles	4	33 *±1.0*	2.6 *±0.9*	*	20 *±0.5*	3.4 *±1.3*	4.6 *±0.2*	0.74 *±0.39*	0.33 *±0.43*	2300
Ravenglass	Mussels	4	0.06 *±0.08*	1.7 *±0.4*	*	4.2 *±0.2*	0.40 *±0.47*	-	0.32 *±0.21*	*	-
"	Cockles	5	1.3 *±0.3*	0.89 *±0.35*	*	7.5 *±0.2*	0.89 *±0.50*	-	0.87 *±0.40*	0.39 *±0.25*	270
"	Crabs	4	4.1 *±0.5*	*	*	2.5 *±0.2*	*	-	*	*	120
"	Lobsters	4	16 *±0.7*	*	*	4.7 *±0.3*	*	-	*	*	3300
Tarn Bay	Winkles	4	19 *±0.6*	1.6 *±0.6*	*	20 *±0.4*	1.3 *±0.6*	-	0.57 *±0.26*	0.19 *±0.26*	-
Saltom Bay	"	4	5.4 *±0.3*	2.6 *±0.5*	0.04 *±0.09*	13 *±0.3*	*	-	0.15 *±0.18*	0.20 *±0.17*	-
Whitehaven	*Nephrops*	4	0.31 *±0.2*	*	*	7.7 *±0.2*	*	-	*	*	530
Parton	Winkles	4	6.2 *±0.4*	1.2 *±0.5*	*	18 *±0.4*	*	-	0.13 *±0.26*	0.13 *±0.19*	-
"	Crabs	4	3.5 *±0.5*	*	*	3.5 *±0.3*	*	-	*	*	-
"	Lobsters	4	2.9 *±0.3*	*	*	5.2 *±0.2*	*	-	*	*	-
Haverigg	Cockles	2	*	0.45 *±0.28*	*	7.0 *±0.2*	0.30 *±0.31*	-	0.28 *±0.21*	0.17 *±0.16*	-
Millom	Mussels	2	*	0.49 *±0.29*	*	2.6 *±0.2*	0.35 *±0.48*	-	*	*	-
Roosebeck	Pacific oysters	4	3.3 *±0.2*	0.06 *±0.08*	*	2.6 *±0.1*	*	-	*	*	-
Morecambe Bay (Flookburgh)	Shrimps	4	*	*	*	10 *±0.3*	*	-	*	*	-
" (Morecambe)	Mussels	4	*	0.35 *±0.16*	*	3.0 *±0.1*	*	-	*	0.05 *±0.10*	-

Table 8. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}								
			^{14}C	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr	^{95}Nb	^{99}Tc	^{103}Ru	^{106}Ru
Morecambe Bay (North-west)	Mussels	2	-	0.39 *±0.11*	*	-	*	*	-	*	0.92 *±0.45*
" (North-west)	" [d]	1	-	0.40 *±0.08*	*	-	*	*	-	*	2.2 *±0.7*
" (Flookburgh)	Cockles	2	110 *±8.1*	0.98 *±0.07*	*	0.71 *±0.05*	*	*	26 *±2.0*	*	2.0 *±0.4*
" (Middleton Sands)	"	2	-	1.0 *±0.1*	*	-	*	*	-	*	1.3 *±0.5*
Fleetwood	Squid	1	-	*	*	-	*	*	-	*	*
"	Whelks	4	55 *±10*	0.10 *±0.07*	*	-	*	*	-	*	0.36 *±0.38*
Isle of Man	Scallops	3	-	*	*	-	*	*	-	*	*
Inner Solway	Shrimps	4	-	*	*	0.16 *±0.01*	*	*	2.5 *±0.2*	*	*
Southerness	Winkles	4	-	0.75 *±0.14*	*	1.9 *±0.1*	*	*	430 *±34*	*	1.9 *±1.1*
Kirkcudbright	Scallops	3	-	0.03 *±0.03*	*	-	*	*	-	*	*
"	Queens	4	-	0.02 *±0.03*	*	-	*	*	-	*	*
North Solway coast	Crabs	4	67 *±11*	0.15 *±0.06*	*	0.34 *±0.03*	*	*	14 *±1.1*	*	*
"	Lobsters	4	59 *±10*	0.05 *±0.08*	*	0.08 *±0.03*	*	*	850 *±66*	*	*
"	Winkles	4	-	0.78 *±0.21*	*	-	*	*	-	*	1.9 *±1.4*
"	Cockles	4	43 *±5.7*	0.81 *±0.07*	*	1.2 *±0.05*	*	*	18 *±1.5*	*	1.5 *±0.4*
"	Mussels	4	-	0.36 *±0.13*	*	-	*	*	-	*	1.3 *±0.8*
Wirral	Shrimps	2	-	*	*	-	*	*	4.7 *±0.4*	*	*
"	Cockles	4	-	0.13 *±0.08*	*	-	*	*	60 *±4.7*	*	*
Conwy	Mussels	2	-	*	*	-	*	*	-	*	*
Northern Ireland	*Nephrops*	6	-	*	*	-	*	*	42 *±3.3*	*	*
"	Winkles	4	-	0.03 *±0.02*	*	-	*	*	-	*	*
"	Mussels	1	-	*	*	-	*	*	22 *±1.7*	*	*
Minch	*Nephrops*	4	-	*	*	-	*	*	-	*	*
Northern North Sea	"	4	-	*	*	-	*	*	-	*	*
Mid North Sea	Mussels[e]	1	-	*	*	-	*	*	-	*	*
Southern North Sea	Cockles	2	-	0.37 *±0.07*	*	-	*	*	-	*	*
"	" [f]	2	-	0.15 *±0.07*	*	-	*	*	-	*	*
"	Mussels	4	-	*	*	-	*	*	-	*	*

Table 8. continued

Location[a]	Material	No. of sampling observations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}								
			^{110m}Ag	^{125}Sb	^{134}Cs	^{137}Cs	^{144}Ce	^{147}Pm	^{154}Eu	^{155}Eu	Total beta
Morecambe Bay (North-west)	Mussels	2	*	0.23 *±0.14*	*	4.1 *±0.2*	*	-	*	0.09 *±0.09*	-
" (North-west)	"[d]	1	*	0.40 *±0.15*	*	3.3 *±0.1*	*	-	*	*	-
" (Flookburgh)	Cockles	2	*	0.24 *±0.15*	*	6.1 *±0.1*	*	-	0.24 *±0.14*	*	-
" (Middleton Sands)	"	2	*	0.18 *±0.12*	*	4.6 *±0.1*	*	-	0.08 *±0.11*	0.06 *±0.06*	-
Fleetwood	Squid	1	*	*	*	1.8 *±0.2*	*	-	*	*	-
"	Whelks	4	0.47 *±0.18*	*	*	1.6 *±0.2*	*	-	*	*	-
Isle of Man	Scallops	3	*	*	*	0.72 *±0.09*	*	-	*	*	-
Inner Solway	Shrimps	4	0.08 *±0.06*	*	*	12 *±0.4*	*	-	*	*	-
Southerness	Winkles	4	2.0 *±0.3*	0.61 *±0.35*	*	12 *±0.2*	*	-	0.08 *±0.13*	*	-
Kirkcudbright	Scallops	3	0.08 *±0.06*	*	*	0.47 *±0.05*	*	-	*	*	-
"	Queens	4	0.06 *±0.04*	*	*	0.44 *±0.09*	*	-	*	*	-
North Solway coast	Crabs	4	1.4 *±0.3*	0.05 *±0.08*	*	2.2 *±0.2*	*	-	*	*	-
"	Lobsters	4	1.2 *±0.3*	*	*	3.1 *±0.2*	*	-	*	*	-
"	Winkles	4	2.7 *±0.4*	0.51 *±0.43*	*	4.2 *±0.2*	*	-	*	*	-
"	Cockles	4	0.01 *±0.02*	0.27 *±0.12*	*	5.7 *±0.1*	0.05 *±0.07*	-	0.28 *±0.14*	0.11 *±0.09*	-
"	Mussels	4	*	0.25 *±0.18*	*	3.7 *±0.2*	*	-	0.04 *±0.09*	*	-
Wirral	Shrimps	2	*	*	*	2.8 *±0.1*	*	-	*	*	-
"	Cockles	4	*	*	*	2.9 *±0.2*	*	-	*	*	-
Conwy	Mussels	2	*	*	*	0.60 *±0.09*	*	-	*	*	-
Northern Ireland	*Nephrops*	6	*	*	*	1.9 *±0.2*	*	-	*	*	-
"	Winkles	4	0.03 *±0.04*	*	*	0.60 *±0.16*	*	-	*	*	-
"	Mussels	1	*	*	*	0.82 *±0.41*	*	-	*	*	-
Minch	*Nephrops*	4	*	*	*	1.2 *±0.1*	*	-	*	*	-
Northern North Sea	"	4	*	*	*	0.19 *±0.11*	*	-	*	*	-
Mid North Sea	Mussels[e]	1	*	*	*	*	*	-	*	*	28
Southern North Sea	Cockles	2	*	*	*	*	*	-	*	*	-
"	"[f]	2	*	*	*	0.06 *±0.04*	*	-	*	0.06 *±0.06*	-
"	Mussels	4	*	*	*	0.26 *±0.24*	*	-	*	*	-

\- *not analysed*
* *not detected by the method used*
[a] *Sampling area or landing point*
[b] *See section 5 for definition*
[c] *Samples collected by Consumer 116*
[d] *Uncooked sample*
[e] *Landed in Denmark*
[f] *Landed in Holland*

Table 9. Transuranic radioactivity in fish and shellfish from the Irish Sea vicinity and further afield, 1995

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}						
			^{237}Np	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm
Sellafield coastal area	Cod	2	-	0.0012 *±0.0001*	0.0058 *±0.0002*	-	0.0092 *±0.0006*	*	0.000052 *±0.000026*
"	Plaice	1	-	0.0014 *±0.0001*	0.0067 *±0.0003*	-	0.014 *±0.0005*	*	*
"	Crabs	2	0.010 *±0.001*	0.094 *±0.005*	0.43 *±0.01*	8.1 *±0.3*	1.9 *±0.1*	0.0011 *±0.0013*	0.0010 *±0.0008*
"	Lobsters	2	0.044 *±0.004*	0.095 *±0.004*	0.43 *±0.01*	6.3 *±0.3*	6.3 *±0.2*	*	0.014 *±0.007*
"	Winkles[c]	1	0.061 *±0.005*	2.0 *±0.1*	10 *±0.3*	130 *±3.9*	19 *±0.4*	0.027 *±0.024*	0.041 *±0.014*
"	Mussels[c]	1	-	2.3 *±0.1*	11 *±0.3*	140 *±4.2*	20 *±0.5*	0.031 *±0.025*	0.040 *±0.016*
"	Limpets[c]	1	-	3.0 *±0.1*	15 *±0.4*	200 *±4.9*	25 *±0.6*	0.063 *±0.039*	0.053 *±0.020*
"	Whelks	1	-	0.37 *±0.02*	1.7 *±0.05*	23 *±0.7*	3.4 *±0.1*	*	0.0062 *±0.0035*
Sellafield offshore area	Cod	1	-	0.0033 *±0.0001*	0.016 *±0.0005*	-	0.028 *±0.001*	0.000046 *±0.000033*	0.000047 *±0.000018*
"	Plaice	1	0.0022 *±0.0003*	0.015 *±0.001*	0.072 *±0.002*	-	0.11 *±0.004*	*	0.00013 *±0.00009*
St Bees	Winkles	1	0.082 *±0.008*	3.4 *±0.2*	17 *±0.4*	220 *±5.4*	31 *±0.7*	0.072 *±0.047*	0.056 *±0.020*
"	Mussels	2	-	1.6 *±0.1*	7.7 *±0.2*	110 *±3.0*	14 *±0.4*	0.015 *±0.011*	0.025 *±0.011*
"	Limpets	1	-	2.9 *±0.1*	13 *±0.3*	-	23 *±0.6*	0.037 *±0.027*	0.076 *±0.024*
Nethertown	Winkles	4	0.087 *±0.008*	4.5 *±0.2*	21 *±0.5*	280 *±7.2*	37 *±0.9*	0.095 *±0.067*	0.064 *±0.027*
"	Mussels	4	-	2.1 *±0.1*	9.7 *±0.3*	-	18 *±0.5*	0.028 *±0.019*	0.040 *±0.016*
Whitriggs	Shrimps	1	-	-	-	-	0.39 *±0.13*	-	-
Drigg	Winkles	4	0.11 *±0.01*	5.3 *±0.3*	25 *±0.8*	340 *±11*	47 *±1.5*	0.17 *±0.17*	0.078 *±0.039*
Ravenglass	Cod	1	-	0.00093 *±0.00007*	0.0043 *±0.0002*	-	0.0062 *±0.0005*	*	0.000063 *±0.000039*
"	Plaice	1	-	0.0018 *±0.0001*	0.009 *±0.00003*	-	0.016 *±0.001*	*	0.000058 *±0.000022*
"	Crabs	1	-	0.050 *±0.002*	0.24 *±0.01*	3.6 *±0.3*	1.1 *±0.03*	0.0026 *±0.0022*	0.0024 *±0.0011*
"	Lobsters	1	-	0.044 *±0.006*	0.23 *±0.02*	3.1 *±0.2*	2.9 *±0.1*	*	0.0059 *±0.0027*
"	Mussels	1	-	1.7 *±0.1*	8.0 *±0.2*	110 *±2.2*	15 *±0.4*	*	0.038 *±0.013*
"	Cockles	1	-	2.2 *±0.1*	11 *±0.3*	140 *±3.9*	32 *±0.7*	*	0.077 *±0.026*
Tarn Bay	Winkles	1	-	2.7 *±0.1*	12 *±0.3*	160 *±4.5*	27 *±0.7*	0.042 *±0.036*	0.067 *±0.026*
Whitehaven	Cod	1	-	0.00035 *±0.00002*	0.0018 *±0.0001*	-	0.0034 *±0.0001*	*	0.0000090 *±0.0000039*
"	Plaice	1	-	0.00064 *±0.00005*	0.0033 *±0.0001*	-	0.0060 *±0.0003*	*	0.000018 *±0.000012*
"	Ray	1	-	0.00040 *±0.00004*	0.0020 *±0.0001*	-	0.0031 *±0.0001*	*	*
"	*Nephrops*	1	-	0.030 *±0.003*	0.16 *±0.01*	-	0.65 *±0.02*	*	0.0015 *±0.0007*
Saltom Bay	Winkles	4	-	-	-	-	15 *±0.6*	-	-

Table 9. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}						
			^{237}Np	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm
Parton	"	1	-	2.5 *±0.1*	12 *±0.3*	150 *±4.1*	20 *±0.5*	*	0.03 *±0.01*
"	Crabs	4	-	-	-	-	0.74 *±0.39*	-	-
"	Lobsters	4	-	-	-	-	0.95 *±0.46*	-	-
Haverigg	Cockles	1	-	1.4 *±0.1*	7.1 *±0.2*	-	20 *±0.6*	*	0.042 *±0.018*
Millom	Mussels	1	-	0.61 *±0.02*	2.9 *±0.1*	-	5.7 *±0.1*	0.0098 *±0.0064*	0.015 *±0.005*
Roosebeck	Pacific oysters	1	-	0.18 *±0.01*	0.88 *±0.04*	-	0.79 *±0.02*	*	0.0014 *±0.0005*
Morecambe Bay (Flookburgh)	Flounder	1	-	0.00064 *±0.00004*	0.0033 *±0.0001*	-	0.0045 *±0.0001*	*	0.000011 *±0.000004*
" (Morecambe)	Whitebait	1	-	0.024 *±0.001*	0.13 *±0.004*	1.5 *±0.2*	0.18 *±0.005*	*	*
" (Flookburgh)	Shrimps	1	-	0.0048 *±0.0003*	0.025 *±0.001*	0.62 *±0.36*	0.039 *±0.001*	*	0.000068 *±0.000037*
" (Morecambe)	Mussels	1	-	0.29 *±0.02*	1.5 *±0.04*	-	2.6 *±0.1*	*	0.0072 *±0.0028*
" (Flookburgh)	Cockles	1	-	0.65 *±0.03*	3.4 *±0.1*	41 *±1.2*	8.4 *±0.2*	*	0.015 *±0.007*
" (Middleton Sands)	"	1	-	0.34 *±0.02*	1.8 *±0.1*	-	4.9 *±0.1*	*	0.011 *±0.004*
" (North-west)	Mussels	1	-	0.25 *±0.01*	1.3 *±0.04*	-	2.3 *±0.1*	*	0.0049 *±0.0022*
" "	" [d]	1	-	-	-	-	2.2 *±0.2*	-	-
Fleetwood	Cod	1	-	0.00021 *±0.00002*	0.0011 *±0.0001*	-	0.0022 *±0.0001*	*	0.0000030 *±0.0000020*
"	Plaice	1	-	0.00065 *±0.00004*	0.0032 *±0.0001*	-	0.0058 *±0.0002*	*	0.00012 *±0.00006*
"	Fish meal[e]	1	-	0.0053 *±0.0003*	0.028 *±0.001*	-	0.048 *±0.002*	*	*
"	Whelks	1	-	0.095 *±0.005*	0.47 *±0.01*	5.8 *±0.5*	0.87 *±0.03*	*	0.0015 *±0.0009*
Isle of Man	Cod	1	-	0.00051 *±0.0004*	0.0025 *±0.0001*	-	0.0046 *±0.0002*	*	0.00084 *±0.00033*
"	Plaice	1	-	0.00015 *±0.00002*	0.0080 *±0.00005*	-	0.0016 *±0.0001*	*	0.0000040 *±0.0000020*
"	Herring	1	-	0.00028 *±0.00003*	0.0014 *±0.0001*	-	0.0020 *±0.0001*	*	*
"	Scallops	1	-	0.024 *±0.001*	0.12 *±0.004*	-	0.027 *±0.001*	*	*
Inner Solway	Flounder	1	-	0.0038 *±0.0001*	0.020 *±0.001*	-	0.031 *±0.001*	0.000026 *±0.000014*	0.000051 *±0.000012*
"	Sea trout	1	-	0.00044 *±0.00005*	0.0021 *±0.0001*	-	0.0032 *±0.0002*	*	0.0000080 *±0.0000059*
"	Shrimps	1	-	0.0036 *±0.0002*	0.019 *±0.001*	-	0.032 *±0.001*	*	*
Southerness	Winkles	1	-	0.88 *±0.03*	4.3 *±0.1*	54 *±1.2*	7.3 *±0.2*	0.015 *±0.013*	0.014 *±0.007*
Kirkcudbright	Plaice	1	-	0.00060 *±0.00005*	0.0032 *±0.0001*	-	0.0060 *±0.0002*	*	0.000012 *±0.000006*
"	Scallops	1	-	0.016 *±0.001*	0.085 *±0.002*	-	0.060 *±0.002*	*	0.00012 *±0.00006*
"	Queens	1	-	0.020 *±0.001*	0.10 *±0.004*	-	0.093 *±0.003*	*	0.00015 *±0.00009*

Table 9. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}						
			^{237}Np	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm
North Solway coast	Crabs	1	-	0.033 *±0.003*	0.16 *±0.01*	2.0 *±0.1*	0.93 *±0.04*	*	0.0026 *±0.0014*
"	Lobsters	1	-	0.022 *±0.002*	0.11 *±0.01*	1.4 *±0.1*	0.70 *±0.03*	*	0.0016 *±0.0010*
"	Winkles	1	-	0.46 *±0.03*	2.6 *±0.1*	31 *±1.0*	4.2 *±0.1*	*	0.0081 *±0.0035*
"	Cockles	4	0.20 *±0.02*	0.81 *±0.05*	4.3 *±0.1*	52 *±1.7*	11 *±0.3*	0.0020 *±0.0034*	0.021 *±0.009*
"	Mussels	1	-	0.61 *±0.03*	3.1 *±0.1*	-	5.2 *±0.1*	*	0.0072 *±0.0035*
Wirral	Cockles	1	-	0.16 *±0.01*	0.85 *±0.03*	-	2.1 *±0.1*	0.0046 *±0.0036*	0.0074 *±0.0028*
Conwy	Mussels	1	-	0.026 *±0.002*	0.14 *±0.005*	-	0.23 *±0.01*	*	0.00066 *±0.00033*
North Anglesey	Rays	1	-	0.00010 *±0.00002*	0.00047 *±0.00004*	-	0.00081 *±0.00005*	*	*
Northern Ireland	Whiting	1	-	0.00099 *±0.00005*	0.0055 *±0.0002*	-	0.0088 *±0.0002*	*	0.000015 *±0.000006*
"	*Nephrops*	1	-	0.0067 *±0.0004*	0.037 *±0.001*	-	0.093 *±0.003*	*	0.00019 *±0.00010*
"	Winkles	1	-	0.048 *±0.002*	0.25 *±0.01*	-	0.19 *±0.01*	*	0.00034 *±0.00014*
Minch	Cod	1	-	0.00016 *±0.00002*	0.00086 *±0.00005*	-	0.0012 *±0.0001*	*	0.0000040 *±0.0000020*
"	Haddock	1	-	0.00022 *±0.00002*	0.0012 *±0.0001*	-	0.0015 *±0.0001*	*	0.0000040 *±0.0000020*
"	Mackerel	1	-	0.000017 *±0.000008*	0.000091 *±0.000020*	-	0.000044 *±0.000014*	*	*
"	*Nephrops*	1	-	0.00091 *±0.00007*	0.0052 *±0.0002*	-	0.0084 *±0.0003*	*	0.000013 *±0.000008*
Shetland	Fish meal[e]	1	-	0.00066 *±0.00004*	0.0057 *±0.0002*	-	0.0013 *±0.0001*	*	0.000010 *±0.000008*
Northern North Sea	Cod	1	-	0.000026 *±0.000006*	0.00015 *±0.00002*	-	0.00025 *±0.00002*	*	*
"	Haddock	1	-	0.000039 *±0.000010*	0.00024 *±0.00003*	-	0.00024 *±0.00003*	*	*
"	*Nephrops*	1	-	0.00015 *±0.00003*	0.0014 *±0.0001*	-	0.0016 *±0.0001*	*	*
Mid North Sea	Mussels[f]	1	-	0.00019 *±0.00003*	0.0023 *±0.0001*	-	0.0011 *±0.0001*	*	0.0000080 *±0.0000059*
Southern North Sea	Cockles	1	-	0.0020 *±0.0001*	0.0059 *±0.0002*	-	0.016 *±0.0005*	0.000097 *±0.000045*	0.0025 *±0.0001*
"	" [g]	1	-	0.0029 *±0.0002*	0.0093 *±0.0004*	-	0.011 *±0.0004*	0.000055 *±0.000041*	0.0012 *±0.0001*
"	Mussels	1	-	0.0031 *±0.0002*	0.019 *±0.001*	-	0.0072 *±0.0003*	*	*
Icelandic processed	Cod	1	-	0.000056 *±0.000012*	0.00029 *±0.00003*	-	0.00043 *±0.00003*	*	*

- not analysed
** not detected by the method used*
[a] *Sampling area or landing point*
[b] *See section 5 for definition*
[c] *Samples collected by Consumer 116*
[d] *Uncleansed sample*
[e] *Concentrations refer to weight as supplied*
[f] *Landed in Denmark*
[g] *Landed in Holland*

Table 10. Individual radiation exposures due to consumption of Irish Sea fish and shellfish, 1995

Exposed population[d]	Critical foodstuffs	Nuclide	Exposure mSv[a]
Consumers in local fishing community	Plaice and cod	^{14}C	0.003
	Crabs and lobsters	^{90}Sr	0.003
	Winkles and other molluscs	^{99}Tc	0.018
		^{106}Ru	0.003
		^{137}Cs	0.007
		^{238}Pu	0.005
		$^{239+240}Pu$	0.027
		^{241}Pu	0.007
		^{241}Am	0.047
		Others	<0.001
		Total	0.12
Consumers associated with commercial fisheries: Whitehaven	Plaice and cod	^{14}C	0.002
	Nephrops	^{99}Tc	0.009
	Whelks	^{137}Cs	0.008
		^{238}Pu	0.001
		$^{239+240}Pu$	0.006
		^{241}Pu	0.001
		^{241}Am	0.011
		Others	<0.002
		Total	0.039
Consumers in Dumfries and Galloway	Plaice, cod and salmon	^{14}C	0.001
	Crabs and *Nephrops*	^{99}Tc	0.004
	Winkles and cockles	^{137}Cs	0.004
		^{238}Pu	0.001
		$^{239+240}Pu$	0.007
		^{241}Pu	0.002
		^{241}Am	0.013
		Others	<0.001
		Total[b]	0.053
Consumers in Morecambe Bay area	Flounders and plaice	^{14}C	0.004
	Shrimps	^{99}Tc	0.002
	Cockles and mussels	^{137}Cs	0.020
		^{238}Pu	0.002
		$^{239+240}Pu$	0.011
		^{241}Am	0.020
		Others	<0.002
		Total[c]	0.073
Consumers associated with commercial fisheries: Fleetwood	Plaice and cod	^{14}C	0.004
	Shrimps	^{99}Tc	0.001
	Whelks	^{137}Cs	0.016
		$^{239+240}Pu$	0.003
		^{241}Am	0.005
		Others	<0.003
		Total	0.031
Typical member of the fish-eating public consuming fish landed at Whitehaven/Fleetwood	Plaice and cod	^{137}Cs	0.001
		Others	<0.001
		Total	0.002

[a] *Due to artificial radionuclides: see text for exposures due to natural radionuclides*
[b] *Including exposure due to 1000 h year^{-1} occupancy over intertidal sediments*
[c] *Including exposure due to 900 h year^{-1} occupancy over intertidal sediments*
[d] *Representative of people most exposed unless stated otherwise*

Table 11. Gamma radiation dose rates over areas of the Cumbrian coast and further afield, 1995

Location	Ground type	No. of sampling observations[a]	Mean gamma dose rate in air at 1 m, $\mu Gy\ h^{-1}$
Cumbria			
Rockliffe Marsh	Salt marsh	4	0.083
Burgh Marsh	"	4	0.097
Port Carlisle	Mud and sand	3	0.084
"	Mud, sand & stones	1	0.092
Greenend	Salt marsh	4	0.082
"	Mud and sand	2	0.072
"	Sand	2	0.071
Cardurnock Marsh	Salt marsh	4	0.10
Newton Arlosh	"	4	0.12
Silloth - silt pond	Grass	2	0.070
" - boat area	Mud and sand	2	0.099
Allonby	Sand	2	0.076
Maryport - Christchurch	Mud	4	0.11
" - outer harbour	"	4	0.11
Siddick	Sand	4	0.075
Workington Harbour	Mud	4	0.14
Harrington Harbour	Mud and sand	4	0.13
Whitehaven - outer harbour	"	12	0.10
" "	Coal and sand	12	0.13
Whitehaven - inner harbour	Mud	1	0.37
" "	Mud and sand	11	0.27
" - yacht basin	Mud	11	0.26
" "	Mud and sand	1	0.29
Fishing vessel A	Cabin[b]	4	0.093
" B	"	4	0.085
" R	"	2	0.083
" U	"	4	0.089
St Bees	Sand	4	0.069
Nethertown	Winkle bed	4	0.10
Sellafield	Sand	4	0.074
R. Calder (Pos. A)	Mud, sand and stones	1	0.10
" " (Pos. B)	Grass	1	0.25
" " (Pos. C)	"	1	0.54
" " (Pos. D)	"	1	0.11
" " (Pos. E)	"	1	0.080
Seascale	Sand	4	0.071
Drigg pipeline	"	8	0.070
Drigg Barn Scar	Mussel bed	4	0.097
Saltcoats	Salt marsh	4	0.22
Muncaster Bridge	"	4	0.22
Ravenglass - Carleton Marsh	"	4	0.26
Ravenglass - salmon garth	Mud and sand	4	0.14
" "	Sand and stones	4	0.086
" "	Mussel bed	4	0.092
" - boat area	Mud and sand	12	0.092
" "	Sand	4	0.065
" - ford	Mud and sand	4	0.11
" - River Mite	Salt marsh	4	0.23
" - Ravenvilla	Mud	1	0.12
" "	Mud and sand	11	0.12
" "	Salt marsh	12	0.24
" - Eskmeals Nature Reserve	"	4	0.25
Newbiggin	Mud	1	0.21
"	Mud and sand	3	0.21
"	Salt marsh	4	0.27
" - west of bridge	Mud, sand & stones	4	0.11
" "	Salt marsh	4	0.25
Tarn Bay	Sand	2	0.066
Silecroft	"	2	0.058
Haverigg	Mud	1	0.094
"	Mud and sand	4	0.083
"	Sand	3	0.067
Millom	Mud and sand	4	0.094
Low Shaw	Salt marsh	4	0.13
Askham	"	4	0.16
Tummer Hill Marsh	"	4	0.17
Walney Channel	Mud and sand	4	0.089
" - Vickers shore	Mud	1	0.10
" "	Mud and sand	3	0.080
" - west shore	Sand	4	0.060
Roa Island	Mud and sand	4	0.076
Greenodd	Salt marsh	2	0.086
Sand Gate Marsh	"	4	0.11
Flookburgh	Mud and sand	4	0.075
High Foulshaw	Salt marsh	4	0.094
Arnside	Mud and sand	4	0.069
"	Salt marsh	4	0.11

Table 11. continued

Location	Ground type	No. of sampling observations[a]	Mean gamma dose rate in air at 1 m, $\mu Gy\ h^{-1}$
Lancashire, Merseyside and North Wales			
Sunderland Point	Mud and sand	4	0.086
Sunderland	Mud, sand & stones	4	0.080
Colloway Marsh	Salt marsh	4	0.16
Lancaster	"	4	0.11
Aldcliffe Marsh	"	4	0.14
Conder Green	Mud	1	0.096
"	Mud and sand	3	0.10
"	Salt marsh	4	0.13
Cockerham Marsh	"	4	0.11
Heads - River Wyre	"	2	0.14
Height o' th' hill - River Wyre	"	4	0.14
Hambleton	Mud	3	0.12
"	Mud and sand	1	0.11
"	Salt marsh	4	0.13
Fleetwood	Sand	4	0.063
" Docks	Salt marsh	4	0.15
Skippool Creek	Mud	5	0.098
"	Mud and sand	2	0.12
" (boat 1)	Cabin[b]	3	0.074
" (boat 2)	"	2	0.085
" (boat 3)	"	3	0.075
Blackpool	Sand	4	0.053
Crossen Marsh	Mud	4	0.11
"	Salt marsh	4	0.11
Ainsdale	Sand	4	0.052
New Brighton	Mussel bed	4	0.071
West Kirby	Mud and sand	2	0.060
Rock Ferry	Mud	3	0.091
"	Mud and sand	1	0.093
Little Neston Marsh	"	2	0.077
"	Salt marsh	2	0.084
Flint	Mud	4	0.092
"	Salt marsh	4	0.12
Prestatyn	Sand	2	0.054
Rhyl	Mud and sand	2	0.071
Llandudno	Gravel	2	0.080
Caerhun	Salt marsh	2	0.097
Llanfairfechan	"	2	0.080
South-west Scotland			
Piltanton Burn	Salt marsh	4	0.076
Garlieston	Mud	3	0.090
"	Mud and sand	1	0.080
Innerwell	Mud	3	0.085
"	Mud and sand	1	0.087
Bladnoch	Mud	4	0.095
Creetown	Salt marsh	4	0.13
Carsluith	Mud	3	0.082
"	Mud and sand	1	0.077
Skyreburn Bay (Water of Fleet)	Salt marsh	4	0.091
Cumstoun	"	4	0.12
Kirkcudbright	"	4	0.10
Cutters Pool	Winkle bed	2	0.085
Rascarrel Bay	"	2	0.11
Palnackie Harbour	Mud	4	0.096
Gardenburn	Salt marsh	4	0.13
Kippford - Slipway	Mud and sand	4	0.089
" - Merse	Salt marsh	4	0.15
Carsethorn	Mud	1	0.10
"	Mud and sand	3	0.085
Glencaple Harbour	"	4	0.085

[a] *See section 5 for definition*
[b] *In the cabin of a boat or houseboat*

Table 12. Radioactivity in sediment from the Cumbrian coast and further afield, 1995

Location	Material	No. of sampling observa-tions[a]	Mean radioactivity concentration (dry), Bq kg^{-1}									
			^{60}Co	^{95}Zr	^{95}Nb	^{106}Ru	^{110m}Ag	^{125}Sb	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu
Cumbria												
Newton Arlosh	Turf	4	2.9 *±1.1*	*	*	*	*	*	1.6 *±1.3*	990 *±8.8*	*	4.7 *±3.0*
Maryport - Christchurch	Mud	4	18 *±2.2*	*	*	140 *±23*	*	8.8 *±5.5*	0.42 *±0.67*	720 *±8.9*	13 *±7.9*	14 *±6.0*
Harrington Harbour	"	4	12 *±1.9*	*	*	96 *±18*	*	6.8 *±4.3*	1.3 *±1.2*	530 *±6.6*	8.8 *±6.7*	11 *±3.5*
Whitehaven - yacht basin	"	4	9.0 *±1.5*	*	*	110 *±19*	*	7.6 *±4.7*	2.2 *±1.5*	1100 *±8.2*	3.5 *±4.7*	16 *±3.7*
Whitehaven - outer harbour	Sand	1	1.0 *±0.5*	*	*	5.3 *±5.0*	*	*	*	140 *±2.1*	*	1.9 *±1.9*
St Bees	"	4	2.0 *±0.5*	*	*	*	*	*	*	98 *±1.4*	*	1.8 *±0.9*
Sellafield	"	4	2.2 *±0.4*	*	*	2.9 *±2.5*	*	0.80 *±0.71*	*	130 *±1.3*	*	3.8 *±1.3*
River Calder (Pos. A)	Mud & sand	1	*	*	*	*	*	*	2.2 *±1.2*	130 *±2.8*	*	*
" (Pos. B)	Mud	1	30 *±2.7*	*	*	41 *±21*	*	*	8.1 *±2.1*	570 *±7.5*	14 *±8.4*	3.9 *±2.3*
" (Pos. C)	"	1	400 *±7.4*	*	*	*	*	9.3 *±9.1*	24 *±3.9*	3400 *±16*	*	10 *±5.6*
" (Pos. D)	"	1	830 *±9.6*	*	*	*	*	*	8.4 *±3.9*	670 *±7.8*	*	*
" (Pos. E)	"	1	1.2 *±0.5*	*	*	*	*	*	*	45 *±1.5*	*	*
Seascale	Sand	4	1.3 *±0.4*	*	*	*	*	0.38 *±0.51*	*	82 *±1.2*	*	2.7 *±1.1*
Drigg - N of pipeline	"	4	2.1 *±0.6*	*	*	6.2 *±4.1*	*	1.0 *±1.1*	*	74 *±1.4*	*	3.4 *±1.6*
River Mite estuary	Mud	4	12 *±1.7*	1.1 *±1.4*	0.88 *±1.5*	160 *±19*	*	9.3 *±4.5*	*	410 *±5.5*	18 *±8.1*	14 *±4.5*
Ravenglass - Carleton Marsh	"	4	38 *±1.8*	2.6 *±1.5*	3.3 *±1.4*	590 *±21*	2.2 *±1.6*	19 *±5.1*	1.9 *±1.4*	880 *±6.0*	58 *±8.5*	27 *±3.5*
" - Ravenvilla	Mud & sand	4	12 *±1.5*	0.78 *±0.86*	1.1 *±1.0*	130 *±15*	*	11 *±4.7*	*	330 *±4.7*	16 *±7.6*	11 *±3.4*
Newbiggin	Mud	4	14 *±1.1*	*	*	160 *±13*	*	10 *±3.7*	0.41 *±0.39*	430 *±4.0*	19 *±6.5*	12 *±2.5*
Millom	Mud & sand	4	3.8 *±0.7*	*	*	32 *±8.5*	*	1.9 *±1.2*	*	210 *±2.9*	2.2 *±2.4*	3.7 *±1.9*
Low Shaw	Turf	4	3.0 *±1.1*	*	*	8.8 *±10*	*	*	2.7 *±1.2*	700 *±7.1*	*	9.5 *±4.0*
Flookburgh	Mud and sand	4	*	*	*	*	*	*	*	110 *±1.6*	*	*
Sand Gate marsh	Turf	4	1.0 *±0.8*	*	*	*	*	*	*	250 *±3.7*	*	*
Lancashire, Merseyside and north Wales												
Sunderland Point	Mud & sand	4	2.9 *±0.7*	*	*	11 *±5.8*	*	1.7 *±1.5*	0.35 *±0.60*	210 *±2.4*	*	0.84 *±1.1*
Conder Green	Turf	4	2.0 *±1.1*	*	*	*	*	3.4 *±3.1*	0.51 *±0.83*	590 *±8.0*	*	2.3 *±3.1*
Hambleton	"	4	3.1 *±1.3*	*	*	*	*	3.1 *±3.2*	1.6 *±1.5*	1300 *±10*	*	5.9 *±3.5*
Skippool Creek	Mud	4	2.7 *±1.1*	*	*	9.4 *±7.2*	*	4.4 *±4.0*	1.5 *±1.2*	550 *±6.6*	*	3.3 *±2.7*
Fleetwood	Sand	4	*	*	*	*	*	*	*	25 *±0.8*	*	*
Blackpool	"	4	*	*	*	*	*	*	*	8.7 *±0.6*	*	*

Table 12. continued

Location	Material	No. of sampling observa-tions[a]	Mean radioactivity concentration (dry), Bq kg^{-1}							
			^{155}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total beta
Cumbria										
Newton Arlosh	Turf	4	*	-	-	-	260 *±13*	-	-	-
Maryport - Christchurch	Mud	4	5.6 *±4.1*	100 *±4.1*	500 *±11*	-	800 *±16*	0.44 *±0.38*	1.6 *±0.5*	-
Harrington Harbour	"	4	3.0 *±2.5*	-	-	-	550 *±13*	-	-	-
Whitehaven - yacht basin	"	4	8.6 *±5.3*	100 *±4.1*	510 *±11*	-	800 *±20*	*	1.9 *±0.7*	2900
Whitehaven - outer harbour	Sand	1	*	-	-	-	180 *±3.3*	-	-	660
St Bees	"	4	0.25 *±0.46*	-	-	-	160 *±3.9*	-	-	-
Sellafield	"	4	1.2 *±0.9*	-	-	-	210 *±3.7*	-	-	-
River Calder (Pos. A)	Mud & sand	1	2.8 *±2.0*	-	-	-	*	-	-	-
" (Pos. B)	Mud	1	*	-	-	-	16 *±2.8*	-	-	-
" (Pos. C)	"	1	7.7 *±5.6*	-	-	-	180 *±9.8*	-	-	-
" (Pos. D)	"	1	*	-	-	-	38 *±11*	-	-	-
" (Pos. E)	"	1	*	-	-	-	6.6 *±3.6*	-	-	-
Seascale	Sand	4	1.2 *±0.9*	-	-	-	170 *±3.6*	-	-	-
Drigg - N of pipeline	"	4	1.9 *±1.2*	-	-	-	210 *±3.6*	-	-	-
River Mite estuary	Mud	4	6.1 *±3.6*	100 *±5.4*	470 *±15*	6100 *±170*	730 *±18*	*	2.0 *±0.7*	-
Ravenglass - Carleton Marsh	"	4	13 *±3.8*	-	-	-	1500 *±14*	-	-	-
" - Ravenvilla	Mud & sand	4	4.7 *±3.3*	-	-	-	580 *±10*	-	-	-
Newbiggin	Mud	4	5.7 *±3.1*	96 *±3.9*	460 *±11*	5800 *±130*	700 *±17*	0.81 *±0.64*	1.9 *±0.6*	1500
Millom	Mud & sand	4	1.8 *±1.2*	-	-	-	200 *±7.1*	-	-	-
Low Shaw	Turf	4	0.77 *±1.5*	-	-	-	520 *±12*	-	-	-
Flookburgh	Mud and sand	4	0.50 *±0.59*	-	-	-	39 *±2.7*	-	-	-
Sand Gate marsh	Turf	4	*	-	-	-	82 *±4.6*	-	-	-
Lancashire, Merseyside and north Wales										
Sunderland Point	Mud & sand	4	2.5 *±1.2*	-	-	-	87 *±3.6*	-	-	-
Conder Green	Turf	4	3.0 *±3.2*	-	-	-	230 *±11*	-	-	-
Hambleton	"	4	5.2 *±4.1*	-	-	-	360 *±12*	-	-	-
Skippool Creek	Mud	4	*	-	-	-	230 *±12*	-	-	-
Fleetwood	Sand	4	*	-	-	-	17 *±2.5*	-	-	-
Blackpool	"	4	*	-	-	-	3.9 *±0.9*	-	-	-

Table 12. continued

Location	Material	No. of sampling observa-tions[a]	Mean radioactivity concentration (dry), Bq kg^{-1}									
			^{60}Co	^{95}Zr	^{95}Nb	^{106}Ru	^{110m}Ag	^{125}Sb	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu
Lancashire, Merseyside and north Wales *continued*												
New Brighton	Mud & sand	1	*	*	*	*	*	*	*	29 *±0.7*	*	*
"	Sand	1	*	*	*	*	*	*	*	7.9 *±0.6*	*	*
Rock Ferry	Mud	4	*	*	*	*	*	*	*	290 *±5.2*	*	0.71 *±1.2*
Rhyl	"	2	*	*	*	*	*	1.7 *±1.1*	*	87 *±1.3*	*	*
Caerhun	Turf	2	*	*	*	*	*	*	0.80 *±0.86*	260 *±4.5*	*	*
Cemlyn Bay	Mud	2	*	*	*	*	*	*	*	180 *±3.1*	*	*
Llanfairfechan	Turf	2	*	*	*	*	*	*	0.76 *±0.85*	150 *±3.4*	*	*
South-west Scotland												
Garlieston	Mud	4	2.3 *±1.1*	*	*	20 *±12*	*	2.4 *±2.8*	*	260 *±4.9*	*	6.4 *±3.6*
Innerwell	"	2	2.7 *±1.5*	*	*	25 *±11*	*	1.7 *±1.7*	*	270 *±3.9*	*	3.8 *±2.5*
Bladnoch	"	4	3.3 *±0.9*	*	*	25 *±8.3*	*	3.7 *±2.5*	0.91 *±0.84*	470 *±3.9*	*	6.1 *±2.1*
Carsluith	"	4	2.6 *±1.0*	*	*	21 *±9.0*	*	2.9 *±2.3*	0.36 *±0.57*	270 *±3.8*	*	4.2 *±2.2*
Kippford Merse	Salt marsh	4	3.6 *±1.4*	*	*	37 *±17*	*	2.9 *±2.5*	0.25 *±0.37*	550 *±6.4*	*	6.8 *±3.4*
" Slipway	Mud	4	2.2 *±0.9*	*	*	28 *±13*	*	2.6 *±3.3*	0.56 *±0.98*	280 *±4.8*	3.0 *±5.4*	2.8 *±2.4*
Palnackie Harbour	"	4	3.0 *±1.1*	*	*	26 *±12*	*	1.2 *±1.1*	*	320 *±4.8*	*	3.4 *±2.3*
Carsethorn	"	2	2.5 *±0.9*	*	*	25 *±7.2*	*	2.1 *±2.6*	0.80 *±0.69*	430 *±4.6*	*	4.8 *±2.2*
Isle of Man												
Douglas	"	1	*	*	*	*	*	*	*	13 *±0.7*	*	*
Northern Ireland												
Lough Foyle	"	2	*	*	*	*	*	*	*	2.4 *±1.0*	*	*
Portrush	Sand	2	*	*	*	*	*	*	*	1.1 *±0.4*	*	*
Ballymacormick	Mud	2	*	*	*	*	*	*	*	55 *±1.2*	*	*
Strangford Lough - Nickey's Pt	"	2	*	*	*	*	*	*	*	35 *±1.1*	*	
Dundrum Bay	"	1	*	*	*	*	*	*	*	10 *±0.8*	*	*
"	Mud & sand	1	*	*	*	*	*	*	*	10 ±0.7	*	*
Carlingford Lough	Mud	2	*	0.81 *±0.70*	*	*	*	*	*	120 *±1.8*	*	*
Oldmill Bay	"	2	*	*	*	*	*	*	*	54	*	*

Table 12. continued

Location	Material	No. of sampling observa-tions[a]	Mean radioactivity concentration (dry), Bq kg^{-1}							
			^{155}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total beta
Lancashire, Merseyside and north Wales *continued*										
New Brighton	Mud & sand	1	*	-	-	-	12 *±2.1*	-	-	-
"	Sand	1	*	-	-	-	2.6 *±0.6*	-	-	-
Rock Ferry	Mud	4	0.74 *±1.4*	-	-	-	79 *±5.8*	-	-	-
Rhyl	"	2	0.92 *±0.65*	-	-	-	26 *±1.7*	-	-	-
Caerhun	Turf	2	1.9 *±1.7*	-	-	-	57 *±5.7*	-	-	-
Cemlyn Bay	Mud	2	*	4.2 *±0.3*	23 *±0.8*	-	33 *±0.9*	*	0.061 *±0.027*	-
Llanfairfechan	Turf	2	*	-	-	-	31 *±4.6*	-	-	-
South-west Scotland										
Garlieston	Mud	4	2.9 *±2.8*	27 *±1.1*	130 *±2.9*	-	210 *±6.1*	*	0.52 *±0.22*	-
Innerwell	"	2	2.7 *±2.0*	-	-	-	240 *±6.4*	-	-	-
Bladnoch	"	4	4.3 *±2.4*	-	-	-	320 *±7.8*	-	-	-
Carsluith	"	4	2.6 *±2.0*	25 *±1.7*	120 *±4.4*	-	190 *±6.7*	*	0.34 *±0.21*	1100
Kippford Merse	Salt marsh	4	2.9 *±2.6*	54 *±3.0*	260 *±7.9*	-	400 *±12*	*	0.96 *±0.41*	-
" Slipway	Mud	4	2.7 *±3.3*	16 *±1.1*	83 *±2.9*	-	140 *±3.9*	*	0.14 *±0.09*	-
Palnackie Harbour	"	4	3.0 *±2.6*	30 *±2.0*	150 *±5.4*	-	240 *±7.0*	*	0.54 *±0.24*	-
Carsethorn	"	2	*	-	-	-	220 *±6.7*	-	-	-
Isle of Man										
Douglas	"	1	1.1 *±0.8*	-	-	-	1.2 *±0.6*	-	-	-
Northern Ireland										
Lough Foyle	"	2	0.91 *±0.75*	0.66 *±0.04*	3.9 *±0.1*	-	4.2 *±0.2*	*	0.010 *±0.005*	-
Portrush	Sand	2	*	-	-	-	*	-	-	-
Ballymacormick	Mud	2	2.2 *±1.3*	2.8 *±0.1*	15 *±0.3*	-	20 *±0.7*	*	0.065 *±0.027*	-
Strangford Lough - Nickey's Pt	"	2	1.9 *±1.1*	0.91 *±0.06*	4.9 *±0.2*	-	5.0 *±0.2*	*	*	-
Dundrum Bay	"	1	*	-	-	-	*	-	-	-
"	Mud & sand	1	*	-	-	-	0.83 *±0.63*	-	-	-
Carlingford Lough	Mud	2	0.72 *±0.77*	2.2 *±0.1*	13 *±0.4*	-	7.7 *±0.2*	*	0.012 *±0.007*	-
Oldmill Bay	"	2	*	1.8 *±0.1*	9.7 *±0.3*	-	13 *±0.4*	*	0.019 *±0.009*	-

- *not analysed*
* *not detected by the method used*
[a] *See section 5 for definition*

Table 13. Beta radiation dose rates on contact with fishing gear on vessels operating off Sellafield, 1995

Vessel	Type of gear	No. of sampling observations[a]	Mean beta dose rate in tissue, $\mu Sv\ h^{-1}$
A	Nets	4	0.19
	Ropes	4	*
B	Nets	5	0.15
	Ropes	5	0.27
D	Gill nets	4	0.16
	Pots	1	0.15
E	Gill nets	4	0.041
	Nets	3	0.27
R	Nets	4	0.091
S	Pots	1	*
	Nets	1	*
T	Gill nets	4	0.052
	Pots	1	0.23
U	Nets	4	0.17
	Ropes	4	*

[a] *See section 5 for definition*
* *Not detected by the method used*

Table 14. Radioactivity in aquatic plants from the Cumbrian coast and further afield, 1995

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg^{-1}												
			^{14}C	^{60}Co	^{90}Sr	^{95}Zr	^{95}Nb	^{99}Tc	^{103}Ru	^{106}Ru	^{110m}Ag	^{125}Sb	^{129}I	^{131}I	^{134}Cs
England															
St Bees	*Fucus vesiculosus*	4	61 *±4.8*	3.6 *±0.1*	3.6 *±0.2*	0.12 *±0.11*	0.06 *±0.13*	21000 *±1800*	*	2.9 *±0.8*	2.1 *±0.2*	1.8 *±0.3*	4.5 *±1.2*	*	0.05 *±0.07*
“	*Porphyra*	4	83 *±4.3*	0.81 *±0.14*	0.18 *±0.01*	*	*	17 *±1.3*	*	19 *±1.4*	0.07 *±0.12*	1.4 *±0.3*	-	*	*
“	*Rhodymenia spp.*	2	-	2.3 *±0.2*	-	0.29 *±0.20*	*	-	*	21 *±1.4*	1.2 *±0.2*	0.53 *±0.25*	-	*	0.23 *±0.10*
Braystones south	*Porphyra*	4	-	1.0 *±0.1*	-	*	*	-	0.13 *±0.09*	26 *±1.3*	0.40 *±0.17*	1.7 *±0.3*	-	*	*
Sellafield	*Fucus vesiculosus*	4	-	7.0 *±0.3*	4.1 *±0.1*	0.11 *±0.12*	*	56000 *±4500*	*	6.3 *±1.8*	4.6 *±0.4*	2.2 *±0.4*	-	*	13 *±0.15*
Seascale	*Porphyra*	52[c]	-	1.3 *±2.6*	-	*	*	-	0.01 *±0.02*	29 *±57*	0.07 *±0.13*	1.8 *±3.6*	-	*	*
River Calder (Pos. A)	*Fontinalis*	1	-	0.57 *±0.31*	-	*	*	-	*	*	*	*	-	*	*
River Calder (Pos. B)	“	1	-	1.8 *±0.1*	-	*	*	-	*	*	*	0.33 *±0.24*	-	*	*
River Calder (Pos. C)	“	1	-	3.7 *±0.2*	-	*	*	-	*	3.7 *±1.6*	*	0.50 *±0.36*	-	*	0.76 *±0.18*
River Calder (Pos. D)	“	1	-	2.2 *±0.3*	-	*	*	-	*	*	*	*	-	*	*
River Calder (Pos. E)	“	1	-	2.6 *±0.6*	-	*	*	-	*	*	*	*	-	*	0.83 *±0.65*
Rabbit Cat How, Ravenglass	Samphire	1	-	*	-	*	*	1.4 *±0.1*	*	*	*	*	-	*	*
Cockerham Marsh	“	1	-	0.02 *±0.02*	-	*	*	-	*	*	*	*	-	*	*
Wales															
Portmadoc	*Fucus vesiculosus*	1	-	*	-	*	*	-	*	*	*	*	-	*	*
Fishguard	“	1	-	*	-	*	*	2.6 *±0.2*	*	*	*	*	-	*	*
Lavernock Point	*Fucus serratus*	2	-	*	-	*	*	-	*	*	*	*	-	2.4 *±0.2*	*
South Wales, Manufacturer A	Laverbread	4	-	*	-	*	*	-	*	*	*	*	-	*	*
Manufacturer C	“	4	-	*	-	*	*	-	*	*	*	*	-	*	*
Manufacturer D	“	4	-	*	-	*	*	-	*	*	*	*	-	*	*
Scotland															
Port William	*Fucus vesiculosus*	4	-	0.08 *±0.06*	-	*	*	1500 *±120*	*	*	*	0.15 *±0.09*	-	*	*
Garlieston	“	4	-	0.46 *±0.13*	-	*	*	2800 *±220*	*	0.18 *±0.32*	0.03 *±0.06*	0.22 *±0.15*	-	*	*
Auchencairn	“	4	-	0.46 *±0.13*	-	*	*	4100 *±330*	*	*	0.12 *±0.10*	0.57 *±0.28*	-	*	*
Knock Bay	*Porphyra*	4	-	0.02 *±0.01*	-	*	*	1.2 *±0.1*	*	0.12 *±0.15*	*	*	-	*	*
Cape Wrath	*Fucus vesiculosus*	1	-	*	-	*	*	86 *±6.8*	*	*	*	*	-	*	*
Wick	“	1	-	*	-	*	*	-	*	*	*	*	-	*	*
Northern Ireland															
Ardglass	“	4	-	*	-	*	*	310 *±24*	*	*	*	*	-	*	*
Portrush	*Fucus serratus*	3	-	0.01 *±0.02*	-	*	*	-	*	*	*	*	-	*	*
Strangford Lough	*Rhodymenia spp.*	4	-	*	-	*	*	38 *±3.0*	*	*	*	*	-	*	*
Isles of Scilly	*Fucus vesiculosus*	1	-	*	-	*	*	0.84 *±0.08*	*	*	*	*	-	*	*

Table 14. continued

Location[a]	Material	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet), Bq kg-1: ^{137}Cs	^{144}Ce	^{154}Eu	^{155}Eu	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Pu	^{241}Am	^{242}Cm	$^{243}Cm+^{244}Cm$	Total beta
England													
St Bees	*Fucus vesiculosus*	4	9.9 *±0.1*	*	0.10 *±0.13*	0.16 *±0.14*	1.9 *±0.1*	8.9 *±0.2*	-	3.7 *±0.1*	0.0078 *±0.0054*	0.0070 *±0.0026*	-
"	*Porphyra*	4	2.3 *±0.1*	*	*	*	0.47 *±0.03*	2.3 *±0.1*	29 *±0.8*	4.2 *±0.1*	*	0.0066 *±0.0026*	210
"	*Rhodymenia spp.*	2	19 *±0.2*	0.27 *±0.27*	0.21 *±0.19*	0.11 *±0.14*	0.94 *±0.05*	4.7 *±0.1*	-	12 *±0.3*	0.012 *±0.010*	0.025 *±0.009*	-
Braystones south	*Porphyra*	4	2.4 *±0.1*	*	0.05 *±0.08*	*	0.59 *±0.04*	2.7 *±0.1*	34 *±1.0*	4.6 *±0.1*	0.0084 *±0.0058*	0.0083 *±0.0035*	-
Sellafield	*Fucus vesiculosus*	4	13 *±0.3*	0.26 *±0.33*	*	*	3.1 *±0.1*	14 *±0.3*	-	6.3 *±0.2*	0.0099 *±0.0079*	0.011 *±0.005*	36000
Seascale	*Porphyra*	52[c]	2.7 *±5.3*	0.04 *±0.8*	0.01 *±0.02*	*	-	-	-	5.8 *±11*	-	-	-
River Calder (Pos. A)	*Fontinalis*	1	3.6 *±0.5*	*	*	1.1 *±0.8*	-	-	-	*	-	-	-
River Calder (Pos. B)	"	1	17 *±0.3*	*	*	1.2 *±0.3*	-	-	-	*	-	-	-
River Calder (Pos. C)	"	1	71 *±0.5*	3.2 *±1.0*	1.1 *±0.3*	1.8 *±0.4*	-	-	-	3.8 *±0.5*	-	-	-
River Calder (Pos. D)	"	1	8.8 *±0.4*	*	*	0.79 *±0.52*	-	-	-	*	-	-	-
River Calder (Pos. E)	"	1	15 *±0.9*	*	*	1.7 *±1.3*	-	-	-	*	-	-	-
Rabbit Cat How, Ravenglass	Samphire	1	2.7 *±0.1*	*	*	*	-	-	-	1.5 *±0.2*	-	-	-
Cockerham Marsh	"	1	3.6 *±0.1*	*	*	*	-	-	-	1.4 *±0.1*	-	-	44
Wales													
Portmadoc	*Fucus vesiculosus*	1	0.38 *±0.05*	*	*	0.14 *±0.11*	-	-	-	*	-	-	-
Fishguard	"	1	0.23 *±0.23*	*	*	*	-	-	-	*	-	-	170
Lavernock Point	*Fucus serratus*	2	0.29 *±0.05*	*	*	0.08 *±0.08*	-	-	-	*	-	-	220
South Wales, Manufacturer A	Laverbread	4	0.04 *±0.04*	*	*	*	-	-	-	*	-	-	-
Manufacturer C	"	4	*	*	*	*	-	-	-	*	-	-	-
Manufacturer D	"	4	0.23 *±0.12*	*	*	*	-	-	-	0.07 *±0.03*	-	-	79
Scotland													
Port William	*Fucus vesiculosus*	4	3.0 *±0.1*	*	*	*	-	-	-	0.53 *±0.20*	-	-	-
Garlieston	"	4	6.3 *±0.2*	*	*	*	-	-	-	3.4 *±0.4*	-	-	-
Auchencairn	"	4	10 *±0.2*	*	*	*	-	-	-	3.1 *±0.3*	-	-	-
Knock Bay	*Porphyra*	4	0.39 *±0.07*	*	*	*	-	-	-	0.32 *±0.15*	-	-	-
Cape Wrath	*Fucus vesiculosus*	1	0.63 *±0.05*	*	0.27 *±0.08*	*	-	-	-	*	-	-	240
Wick	"	1	0.28 *±0.07*	*	*	*	-	-	-	*	-	-	210
Northern Ireland													
Ardglass	"	4	1.1 *±0.1*	*	*	*	-	-	-	0.06 *±0.05*	-	-	-
Portrush	*Fucus serratus*	3	0.42 *±0.06*	*	*	*	-	-	-	*	-	-	-
Strangford Lough	*Rhodymenia spp.*	4	2.5 *±0.2*	*	*	*	0.069 *±0.005*	0.37 *±0.01*	-	0.52 *±0.02*	*	0.0013 *±0.0006*	-
Isles of Scilly	*Fucus vesiculosus*	1	*	*	*	*	-	-	-	*	-	-	87

- not analysed
** not detected by the method used*

Table 15. Beta radiation dose rates over intertidal areas of the Cumbrian coast, 1995

Location	Ground type	No. of sampling observations[a]	$\mu Sv\ h^{-1}$
Whitehaven outer harbour	Mud and sand	2	0.67
" yacht basin	Mud	2	2.2
St Bees	Sand	2	0.19
Nethertown	Winkle bed	2	0.43
Braystones	Sand	2	0.31
Sellafield pipeline	"	2	0.35
River Ehen	Saltmarsh	2	1.5
Seascale	Sand	2	0.13
Drigg	"	2	0.14
Drigg Barn Scar	Mussel bed	2	0.47
Ravenglass - Raven Villa	Saltmarsh	2	0.88
" - salmon garth	Mussel bed	2	0.48
Tarn Bay	Sand	2	*

[a] *See section 5 for definition*
* *Not detected by the method used*

Table 16. ***Radioactivity in terrestrial food and the environment near Sellafield, 1995***

Material		Selection[d]	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
				^{3}H	^{14}C	^{35}S	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{125}Sb	^{129}I	^{131}I
Milk	Near farms[c]		12	<10 *±1.6*	19 *±3.3*	<2.1 *±0.3*	<0.44	<0.22 *±0.01*	<0.04	<2.9	<0.83	<0.016 *±0.003*	<0.20
"	"	max		<13 *±4.3*	29 *±3.6*	<9.2 *±0.7*	<0.48	0.39 *±0.02*		<3.1	<0.90	<0.018 *±0.005*	
"	"	sub-sets	4	-	-	-	<0.33	0.15 *±0.01*	-	<1.7	<0.52	-	<0.10
"	"	max					<0.37	0.18 *±0.01*			<0.60		
"	Far farms[c]		4	<10	17 *±3.3*	<1.0	<0.43	<0.20	<0.04	<2.9	<0.86	<0.017	-
"	"	max			18 *±3.3*		<0.48			<3.3	<0.90	<0.018	
"	"	sub-sets	1	-	-	-	-	0.075 *±0.010*	-	-	-	-	-
Apples			2	<10	19 *±3.5*	<1.3 *±0.3*	<0.45	<0.20	<0.10	<2.6	<0.85	<0.050	-
"		max			24 *±4.0*	1.6 *±0.4*	<0.50			<3.1	<0.90		
Barley			1	<10	120 *±15*	17 *±0.7*	<0.60	1.4 *±0.1*	-	<3.4	<0.90	<0.050	-
Blackberries			1	41 *±5.0*	66 *±5.0*	6.4 *±0.9*	<0.50	7.8 *±0.4*	-	<2.9	<1.1	<0.050	-
Bovine kidney			1	<10	23 *±9.0*	<3.0	<0.40	<0.20	-	<3.9	<0.80	-	-
"	liver		1	<10	54 *±8.0*	<3.0	<0.40	<0.20	<0.10	<2.7	<0.90	<0.050	-
"	muscle		1	<10	34 *±8.0*	7.0 *±7.0*	<0.60	<0.20	<0.10	<2.7	<1.2	<0.050	-
Cabbage			1	-	-	-	-	-	-	-	-	-	-
Carrots			1	21 *±5.0*	13 *±4.0*	<1.0	<0.30	5.6 *±0.3*	<0.10	<3.5	<1.1	<0.060	-
Eggs			1	34 *±5.0*	37 *±5.0*	2.7 *±0.5*	<0.60	<0.20	-	<3.8	<0.60	0.20 *±0.07*	-
Elderberries			1	29 *±5.0*	36 *±6.0*	1.4 *±0.7*	1.8 *±0.2*	3.6 *±0.2*	-	<4.0	<1.1	0.066 *±0.065*	-
Goats milk			2	<10 *±3.5*	15 *±3.0*	<1.0	<0.40	0.45 *±0.02*	-	<3.1	<0.55	<0.082 *±0.016*	-
"		max		10 *±5.0*				0.68 *±0.02*		<3.3	<0.60	0.11 *±0.02*	
Goose			1	<10	54 *±8.0*	<3.0	<0.50	<0.20	<0.10	<4.0	<1.0	<0.050	-
Hare			1	<10	38 *±8.0*	7.1 *±1.6*	<0.40	<0.20	<0.10	<3.9	<1.0	<0.050	-
Honey			1	<10	78 *±16*	<1.0	<0.50	<0.20	-	<3.8	<1.0	<0.050	-
Lettuce			1	<10	<15	<1.0	<0.30	1.1 *±0.1*	-	<3.8	<0.90	<0.050	-
Mushrooms			1	<10	22 *±3.0*	<1.0	<0.60	0.26 *±0.04*	-	<4.0	<1.4	0.082 *±0.061*	-
Oats			1	16 *±8.0*	130 *±16*	8.9 *±0.9*	<0.50	6.0 *±0.3*	-	<3.9	<0.50	0.14 *±0.07*	-
Ovine kidney			1	<10	28 *±5.0*	-	-	-	-	-	-	-	-
"	kidney/liver		1	<10	28 *±5.0*	<3.0	<0.50	<0.20	-	<4.0	<1.5	-	-
"	muscle		2	<14 *±5.7*	36 *±6.0*	<3.0	<0.40	<0.20	<0.10	<3.0	<0.85	<0.058 *±0.041*	-
"	"	max		17 *±8.0*	52 *±7.0*		<0.50			<3.2	<0.90	0.065 *±0.058*	
Peas			1	<10	12 *±3.0*	<1.0	<0.70	<0.20	-	<3.9	<1.3	<0.050	-
Potatoes			2	17 *±5.0*	20 *±3.5*	<1.0	<0.40	0.72 *±0.05*	-	<3.4	<0.90	<0.06	-
"		max		22 *±5.0*	25 *±4.0*			1.2 *±0.1*	-			<0.07	-
"		sub-sets	1	-	-	-	<0.40	-	-	<2.0	<0.70	-	-
Rabbit			1	<10	24 *±12*	<3.0	<0.40	0.47 *±0.05*	<0.10	<3.9	<1.1	<0.050	-
Runner beans			1	<10	13 *±4.0*	<1.0	<0.50	0.39 *±0.04*	-	<2.7	<0.80	0.14 *±0.06*	-
Spinach			1	-	-	-	-	-	-	-	-	<0.050	-
Turnips			1	-	-	-	-	-	-	-	-	-	-
Fodder beet			1	25 *±5.0*	26 *±3.0*	1.7 *±0.4*	<0.50	1.9 *±0.1*	-	<2.3	<0.90	<0.050	-
Grass			2	-	-	270 *±14*	-	-	<0.10	-	-	-	-
Soil			2	-	-	-	-	-	-	-	-	-	-
Dry cloths			346	-	-	-	-	-	-	-	-	-	-

Table 16. continued

Material		Selection	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}						
				^{134}Cs	^{137}Cs	Total Cs	^{144}Ce	^{210}Po	Total U	^{238}Pu
Milk	Near farms[c]		12	<0.33	<0.50 ±*0.04*	<0.27 ±*0.02*	<1.8	<0.010 ±*0.004*	-	<0.00020
"	"	max		<0.38	<0.55 ±*0.09*	0.50 ±*0.03*	<1.9	<0.011 ±*0.005*		
"	"	sub-sets	4	<0.21	<0.43 ±*0.09*	-	<1.2	-	-	<0.00020
"	"	max		<0.23	0.77 ±*0.10*		<1.4			
"	Far farms[c]		4	<0.30	<0.47	<0.21 ±*0.02*	<1.8	-	-	-
"	"	max		<0.33	<0.48	<0.23 ±*0.04*	<1.9			
"	"	sub-sets	1	-	-	-	-	-	-	-
Apples			2	-	-	0.32 ±*0.07*	<1.3	0.028 ±*0.004*	-	<0.0003 ±*0.00021*
"		max				0.43 ±*0.08*	<1.7			0.00040 ±*0.00030*
Barley			1	-	-	0.95 ±*0.11*	<2.0	-	-	0.00070 ±*0.00040*
Blackberries			1	-	-	2.5 ±*0.1*	<0.90	-	-	0.0058 ±*0.0013*
Bovine kidney			1	-	-	0.65 ±*0.09*	<1.8	0.025 ±*0.009*	-	-
"	liver		1	-	-	0.78 ±*0.09*	<1.3	0.35 ±*0.08*	-	<0.00070
"	muscle		1	-	-	0.58 ±*0.09*	<1.6	2.5 ±*0.2*	-	<0.00020
Cabbage			1	-	-	-	-	0.033 ±*0.007*	-	-
Carrots			1	-	-	0.28 ±*0.08*	<1.9	-	-	<0.00020
Eggs			1	-	-	<0.20	<1.7	-	-	0.00030 ±*0.00030*
Elderberries			1	-	-	11 ±*0.6*	<2.9	-	-	0.030 ±*0.005*
Goats milk			2	-	-	1.1 ±*0.1*	<2.0	-	-	<0.00020
"		max				1.5 ±*0.1*				
Goose			1	-	-	0.92 ±*0.14*	<2.3	-	-	<0.00020
Hare			1	-	-	4.5 ±*0.2*	<2.0	-	-	<0.00020
Honey			1	-	-	1.1 ±*0.1*	<1.2	-	-	0.00050 ±*0.00040*
Lettuce			1	-	-	1.9 ±*0.1*	<1.9	0.71 ±*0.05*	-	0.00050 ±*0.00040*
Mushrooms			1	-	-	0.77 ±*0.11*	<1.1	-	-	0.0012 ±*0.0005*
Oats			1	-	-	2.1 ±*0.1*	<1.6	-	-	0.0068 ±*0.0020*
Ovine kidney			1	-	-	-	-	-	-	-
"	kidney/liver		1	-	-	1.4 ±*0.1*	<2.4	0.56 ±*0.16*	-	0.00030 ±*0.00030*
"	muscle		2	-	-	1.4 ±*0.1*	<1.5	0.015 ±*0.006*	-	<0.00020
"	"	max				1.6 ±*0.1*	<2.1			
Peas			1	-	-	<0.20	<1.8	<0.010	-	<0.00020
Potatoes			2	-	-	<0.34 ±*0.06*	<1.9	0.021 ±*0.004*	-	<0.0004 ±*0.00028*
"		max		-	-	0.49 ±*0.08*				0.00060 ±*0.00040*
"		sub-sets	1	-	-	-	<1.2	-	-	-
Rabbit			1	-	-	5.5 ±*0.3*	<2.2	0.037 ±*0.017*	-	<0.00020
Runner beans			1	-	-	<0.20	<2.0	-	-	<0.00020
Spinach			1	-	-	-	-	-	<0.025	-
Turnips			1	-	-	-	-	0.017 ±*0.003*	0.018 ±*0.005*	-
Fodder beet			1	-	-	0.24 ±*0.08*	<1.2	-	-	<0.00020
Grass			2	-	-	-	-	-	-	-
Soil			2	-	-	-	-	64 ±*7.8*	-	-
Dry cloths			346	-	-	-	-	-	-	-

Table 16. continued

Material		Selection[d]	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}					
				^{239}Pu + ^{240}Pu	^{241}Pu	^{241}Am	Total alpha	Total beta	Total gamma
Milk	Near farms		12	<0.00021 *±0.00008*	<0.10	<0.00020	-	-	-
"	"	max		<0.00023 *±0.00015*					
"	"	sub-sets	4	-	-	-	-	-	-
"	"	max							
"	Far farms[c]		4	-	-	-	-	-	-
"	"	max							
"	"	sub-sets	1	-	-	-	-	-	-
Apples			2	0.00065 *±0.00045*	<0.10	0.0011 *±0.0006*	-	-	-
"		max		0.00070 *±0.00050*		0.0017 *±0.0007*			
Barley			1	0.0049 *±0.0014*	<0.10	0.0045 *±0.0016*	-	-	-
Blackberries			1	0.042 *±0.007*	0.47 *±0.10*	0.025 *±0.006*	-	-	-
Bovine kidney			1	-	-	-	-	-	-
"	liver		1	<0.00050	<0.26	0.0014 *±0.0008*	-	-	-
"	muscle		1	<0.00020	<0.10	<0.00020	-	-	-
Cabbage			1	-	-	-	-	-	-
Carrots			1	0.012 *±0.002*	<0.10	0.0051 *±0.0018*	-	-	-
Eggs			1	0.00040 *±0.00040*	0.21 *±0.19*	0.00030 *±0.00030*	-	-	-
Elderberries			1	0.17 *±0.03*	2.2 *±0.2*	0.063 *±0.014*	-	-	-
Goats milk			2	<0.00020	<0.10	<0.00020	-	-	-
"		max							
Goose			1	<0.00030	<0.10	<0.00030	-	-	-
Hare			1	0.00080 *±0.00040*	<0.10	0.0012 *±0.0006*	-	-	-
Honey			1	0.0023 *±0.0013*	0.21 *±0.21*	0.0012 *±0.0007*	-	-	-
Lettuce			1	0.0082 *±0.0022*	<0.10	0.0045 *±0.0015*	-	-	-
Mushrooms			1	0.024 *±0.004*	0.11 *±0.02*	0.011 *±0.005*	-	-	-
Oats			1	0.072 *±0.015*	0.47 *±0.15*	0.038 *±0.015*	-	-	-
Ovine kidney			1	-	-	-	-	-	-
"	kidney/liver		1	0.0012 *±0.0006*	-	<0.00070	-	-	-
"	muscle		2	<0.00025 *±0.00021*	<0.10	<0.00020	-	-	-
"	"	max		0.00030 *±0.00030*					
Peas			1	<0.00020	<0.10	0.00020 *±0.00020*	-	-	-
Potatoes			2	0.010 *±0.003*	<0.10	0.0031 *±0.0013*	-	-	-
"		max		0.020 *±0.004*		0.0059 *±0.0018*			
"		sub-sets	1	-	-	-	-	-	-
Rabbit			1	0.00030 *±0.00030*	<0.10	<0.00020	-	-	-
Runner beans			1	0.00030 *±0.00030*	<0.10	0.00040 *±0.00030*	-	-	-
Spinach			1	-	-	-	-	-	-
Turnips			1	-	-	-	-	-	-
Fodder beet			1	0.0070 *±0.0014*	<0.10	0.0026 *±0.0009*	-	-	-
Grass			2	-	-	-	-	-	-
Soil			2	-	-	-	-	-	-
Dry cloths			346	-	-	-	0.64 *±1.3*	2.7 *±3.2*	1.5

- not analysed
[a] except for milk where units are Bq l^{-1} and for dry cloths where units are Bq per cloth
[b] see section 5 for definition
[c] the concentration of ^{3}H (organic) was <10 Bq l^{-1}
[d] data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition

Table 17. Individual radiation exposures due to consumption of terrestrial foodstuffs near Sellafield and Drigg, 1995

Exposed population[b]	Critical foodstuffs	Nuclide	Exposure, mSv[a]
Consumers near Sellafield aged 1 y	Milk Root vegetables	^{14}C	<0.011
		^{35}S	<0.016
		^{60}Co	<0.004
		^{90}Sr	<0.024
		^{106}Ru	<0.009
		^{125}Sb	<0.001
		^{129}I	<0.002
		^{131}I	<0.006
		^{134}Cs	<0.002
		^{137}Cs	<0.004
		Others	<0.002
		Total	<0.081
Consumers near Drigg aged 1 y	Milk Potatoes	^{35}S	<0.002
		^{60}Co	<0.005
		^{90}Sr	<0.005
		^{95}Zr	<0.003
		^{106}Ru	<0.008
		^{125}Sb	<0.002
		^{129}I	<0.002
		^{134}Cs	<0.002
		^{137}Cs	<0.002
		^{144}Ce	<0.003
		Others	<0.001
		Total	<0.035
Consumers near Ravenglass aged 1 y	Milk Fruit	^{35}S	<0.002
		^{60}Co	<0.004
		^{90}Sr	<0.004
		^{95}Zr	<0.002
		^{106}Ru	<0.009
		^{125}Sb	<0.002
		^{129}I	<0.002
		^{134}Cs	<0.002
		^{137}Cs	<0.002
		^{144}Ce	<0.004
		Others	<0.004
		Total	<0.037
Typical adult member of the public eating food grown near Sellafield	Milk Wildfruit	^{14}C	<0.002
		^{35}S	<0.001
		^{90}Sr	<0.008
		^{106}Ru	<0.003
		^{129}I	<0.002
		^{137}Cs	<0.004
		Others	<0.004
		Total	<0.023

[a] *Excluding natural radionuclides*
[b] *Representative of people most exposed unless stated otherwise*

Table 18. ***Radioactivity in terrestrial food and the environment near Ravenglass, 1995***

Material and selection[d]	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}											
		^{3}H	^{14}C	^{35}S	^{60}Co	^{90}Sr	^{95}Zr	^{95}Nb	^{99}Tc	^{106}Ru	^{125}Sb	^{129}I	^{134}Cs
Milk[c]	5	<10	17 *±3.0*	<1.0	<0.44	<0.20	<0.88	<0.77	<0.040	<3.0	<0.86	<0.016	<0.29
" max			18 *±3.0*		<0.55		<0.95	<0.90		<3.5	<0.96	<0.020	<0.33
" sub-sets	3	-	-	-	<0.28	0.078 *±0.011*	<0.60	<0.57	-	<1.9	<0.60	-	<0.25
" max					<0.35	0.088 *±0.011*	<0.70	<0.60			<0.70		<0.30
Apples	1	<10	<15	<1.0	<0.50	<0.20	<0.70	<0.50	-	<3.3	<0.70	<0.050	-
Barley	1	<10	79 *±19*	1.3 *±0.60*	<0.50	0.58 *±0.05*	<1.1	<0.70	-	<2.7	<1.1	<0.050	-
Blackberries	1	<10	22 *±5.0*	<1.0	<0.50	0.75 *±0.05*	<1.0	<0.80	-	<2.9	<0.80	<0.050	-
Bovine kidney	1	<10	25 *±6.0*	<3.0	<0.50	0.45 *±0.04*	<1.6	<1.5	-	<3.8	<0.80	-	-
" liver	1	<10	24 *±6.0*	<3.0	<0.50	<0.20	<1.0	<0.90	<0.10	<2.7	<0.70	<0.050	-
" muscle	1	<10	31 *±5.0*	<3.0	<0.70	<0.20	<1.7	<1.3	<0.10	<3.3	<1.0	<0.050	-
Cabbage	1	<10	<15	<1.0	<0.40	0.55 *±0.05*	<0.90	<0.50	<0.10	<3.1	<0.90	<0.050	-
Carrots	1	<10	<15	<1.0	<0.50	0.27 *±0.04*	<1.2	<0.80	<0.10	<2.5	<0.70	<0.050	-
Damsons	1	-	-	-	-	-	-	-	-	-	-	-	-
Duck	1	<10	110 *±7.0*	<3.0	<0.50	<0.20	<1.8	<2.9	-	<3.9	<0.5	-	-
Mushrooms	1	<10	<15	<1.0	<0.80	0.42 *±0.04*	<3.1	<4.3	-	<3.8	<2.0	-	-
Ovine kidney/liver	2	<10	36 *±7.5*	<3.0	<0.55	<0.20	<0.95	<0.95	-	<3.7	<0.90	-	-
" max			41 *±7.0*		<0.70		<1.1	<1.1			<1.0		
" muscle	2	<10	41 *±7.5*	<3.0	<0.40	<0.20	<1.2	<1.1	<0.10	<2.4	<1.0	<0.050	-
" max			44 *±8.0*				<1.4	<1.5		<2.6			
Potatoes	1	<10	21 *±3.0*	<1.0	-	<0.20	-	-	-	-	-	<0.050	-
" sub-sets	1	-	-	-	<0.40	-	<0.50	<0.60	-	<1.9	<0.50	-	-
Runner beans	1	<10	<15	<1.0	<0.60	<0.20	<0.70	<0.60	-	<2.8	<0.80	<0.050	-
Turnips	1	-	-	-	-	-	-	-	-	-	-	-	-
Grass	2	-	-	-	-	-	-	-	<3.7 *±0.3*	<0.10[e]	-	-	-
" max									7.4 *±0.4*				
Soil	2	-	-	-	-	-	-	-	-	-	-	-	-
" max													

Table 18. continued

Material and selection	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
		^{137}Cs	Total Cs	^{144}Ce	^{147}Pm	^{210}Po	Total U	^{238}Pu	^{239}Pu + ^{240}Pu	^{241}Pu	^{241}Am
Milk[c]	5	<0.49	<0.22	<1.9 *±0.02*	<0.53	<0.010	-	<0.00021	<0.00021 *±0.00007*	<0.10 *±0.00007*	<0.00023 *±0.00009*
" max		<0.51	<0.24 *±0.02*	<2.2	<0.60			<0.00025 *±0.00015*	<0.00023 *±0.00012*		<0.0003 *±0.00012*
" sub-sets	3	<0.33	-	<1.1	-	-	-	-	-	-	-
" max		<0.40		<1.2							
Apples	1	-	<0.20	<1.8	-	-	-	<0.00020	0.00040 *±0.00030*	<0.10	0.00040 *±0.00040*
Barley	1	-	0.37 *±0.10*	<1.4	-	-	-	0.00020 *±0.00020*	0.00080 *±0.00050*	<0.10	0.0020 *±0.0009*
Blackberries	1	-	0.52 *±0.09*	<1.5	-	-	-	0.00050 *±0.00040*	0.0037 *±0.0010*	<0.10	0.0047 *±0.0013*
Bovine kidney	1	-	0.84 *±0.09*	<1.8	-	-	-	-	-	-	-
" liver	1	-	0.79 *±0.13*	<2.3	-	-	-	0.00090 *±0.00040*	0.0037 *±0.0009*	<0.10	0.0054 *±0.0015*
" muscle	1	-	1.0	<2.5 *±0.1*	-	-	-	<0.00020	0.00030	<0.10 *±0.00030*	<0.00020
Cabbage	1	-	0.25	<1.1 *±0.07*	-	-	-	<0.00020	<0.00020	<0.10	<0.00020
Carrots	1	-	<0.20	<1.5	-	-	-	0.00030 *±0.00030*	0.00060 *±0.00040*	<0.10	0.0011 *±0.0006*
Damsons	1	-	-	-	-	-	<0.048	-	-	-	-
Duck	1	-	6.6 *±0.3*	<2.3	-	-	-	-	-	-	-
Mushrooms	1	-	4.7 *±0.2*	<2.7	-	-	-	0.13 *±0.02*	0.62 *±0.09*	7.7 *±0.5*	2.2 *±0.3*
Ovine kidney/ liver	2	-	2.0 *±0.1*	<1.3	-	-	-	0.0029 *±0.0009*	0.014 *±0.003*	0.30 *±0.11*	0.013 *±0.004*
" max			2.5 *±0.1*	<1.5							
Ovine muscle	2	-	3.4 *±0.2*	<1.7	-	-	-	<0.00020	<0.00055 *±0.00035*	<0.10	0.0014 *±0.0006*
" max			3.5 *±0.2*	<2.0					0.00090 *±0.00050*		0.0023 *±0.0008*
Potatoes	1	-	0.25 *±0.07*	-	-	-	-	<0.00020	0.00090 *±0.00040*	<0.10	0.0011 *±0.0004*
" sub-sets	1	-	-	<1.5	-	-	-	-	-	-	-
Runner beans	1	-	<0.20	<1.6		-	-	<0.00020	<0.00020	<0.10	<0.00020
Turnips	1	-	-	-	-	-	0.044 *±0.012*	-	-	-	-
Grass	2	-	-	-	-	-	-	-	-	-	-
" max											
Soil	2	-	-	-	-	-	75 *±8.1*	-	-	-	-
" max							89				

- not analysed
[a] except for milk where units are Bq l^{-1} and for soil where dry concentrations apply
[b] see section 5 for definition
[c] The concentration of ^{3}H (organic) was <10 Bq l^{-1}
[d] data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition
[e] Total Ru

Table 19. Radioactivity in terrestrial food and the environment near Drigg, 1995

Material and selection[d]	Farms/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}										
		^{3}H	^{14}C	^{35}S	^{60}Co	^{90}Sr	^{95}Zr	^{95}Nb	^{99}Tc	^{106}Ru	^{125}Sb	^{129}I
Milk[c]	1	<10	16 *±3.0*	<1.0	<0.47	<0.20	<0.84	<0.78	<0.040	<3.1	<0.93	<0.020
" sub-sets		-	-	-	-	0.12 *±0.01*	-	-	-	-	-	-
Blackberries	1	14 *±5.0*	30 *±4.0*	<1.0	<0.20	2.0 *±0.1*	<0.70	<0.40	-	<2.0	<0.50	<0.050
Cabbage	1	<10	<15	<1.0	<0.60	0.26 *±0.04*	<1.2	<1.1	<0.10	<3.6	<1.2	<0.050
Honey	1	<10	71 *±15*	<1.0	<0.60	<0.20	<1.4	<1.1	-	<3.5	<0.60	<0.050
Mushrooms	1	16 *±5.0*	<15	<1.0	<0.70	<0.20	<1.4	<0.90	<0.10	<3.6	<1.0	<0.050
Ovine muscle	1	<10	31 *±9.0*	<3.0	<0.60	<0.20	<1.1	<1.2	<0.10	<3.8	<0.9	<0.050
Potatoes	1	<10	19 *±4.0*	<1.0	<0.40	<0.20	<0.70	<0.60	<0.10	<3.7	<0.80	<0.050
Rabbit	1	<10	19 *±11*	<3.0	<0.40	<0.20	<1.9	<2.3	<0.10	<3.4	<1.1	<0.050
Grass	2	-	-	-	-	-	-	-	<0.10 *±0.03*	-	-	-
" max									0.11 *±0.04*			
Soil	2	-	-	-	-	-	-	-	-	-	-	-
" max												

Material and selection[d]	Farm/ samples[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
		^{134}Cs	^{137}Cs	Total Cs	^{144}Ce	^{147}Pm	Total U	^{238}Pu	$^{239}Pu + ^{240}Pu$	^{241}Pu	^{241}Am
Milk[c]	1	<0.32	<0.53 *±0.03*	0.30 *±0.03*	<1.94	<0.50	-	<0.00020	<0.00020	<0.10	<0.00027 *±0.00012*
" sub-sets		-	-	-	-	-	-	-	-	-	-
Blackberries	1	-	-	0.32 *±0.07*	<1.2	-	-	0.00060 *±0.00040*	0.0064 *±0.0016*	<0.10	0.0060 *±0.0020*
Cabbage	1	-	-	<0.20	<2.5	-	<0.023	<0.00020	<0.00020	<0.10	0.00030 *±0.00030*
Honey	1	-	-	<0.20	<1.4	-	-	0.00030 *±0.00020*	0.0010 *±0.0004*	<0.10	0.0013 *±0.0007*
Mushrooms	1	-	-	0.43 *±0.08*	<2.7	-	-	0.0022 *±0.0008*	0.024 *±0.004*	<0.10	0.015 *±0.004*
Ovine muscle	1	-	-	5.8 *±0.2*	<2.5	-	-	<0.00030	0.00040 *±0.00040*	<0.10	<0.00040
Potatoes	1	-	-	<0.20	<1.6	-	<0.026	<0.00020	0.0010 *±0.0005*	<0.10	0.00080 *±0.00040*
Rabbit	1	-	-	1.0 *±0.1*	<2.6	-		<0.00030	0.00060 *±0.00050*	0.13 *±0.13*	0.0011 *±0.0005*
Grass	2	-	-	-	-	-	0.11 *±0.03*	-	-	-	-
" max							0.14 *±0.04*				
Soil	2	-	-	-	-	-	68 *±7.8*	-	-	-	-
" max							100 *±9.4*				

- *not analysed*
[a] *except for milk where units are Bq l^{-1} and for soil where dry concentrations apply*
[b] *see section 5 for definition*
[c] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*
[d] *data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.*

Table 20(a). Radioactivity in food and the environment near Springfields, 1995

Material	Location[b] or selection[c]	No. of sampling observ- ations[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}								
			^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{125}Sb	^{134}Cs	^{137}Cs	Total Cs	^{154}Eu
Aquatic samples											
Flounder	Ribble Estuary	1	*	-	-	*	*	*	12 ±*0.3*	-	*
Salmon	"	1	*	-	-	*	*	*	0.57 ±*0.23*	-	*
Sea trout	"	1	*	-	-	*	*	*	3.6 ±*0.2*	-	*
Shrimps	"	1	*	-	3.3 ±*0.3*	*	*	*	4.2 ±*0.3*	-	*
Turf	Hesketh Bank	4	1.6 ±*0.6*	-	-	2.0 ±*2.6*	3.5 ±*2.2*	0.56 ±*0.63*	570 ±*3.8*	-	3.6 ±*1.8*
Mud	Becconsall	4	1.4 ±*1.3*	-	-	*	2.4 ±*3.1*	*	390 ±*6.3*	-	*
"	Pipeline	4	2.6 ±*1.3*	-	-	*	2.4 ±*1.9*	*	480 ±*6.0*	-	2.9 ±*2.3*
Mud & sand	"	4	0.36 ±*0.61*	-	-	*	3.6 ±*2.8*	*	160 ±*3.5*	-	*
"	Deepdale Brook	4	0.32 ±*0.40*	-	-	*	1.3 ±*1.3*	*	18 ±*1.1*	-	*
Mud	Savick Brook	4	2.7 ±*1.2*	-	-	3.4 ±*5.5*	0.92 ±*1.6*	*	530 ±*6.8*	-	*
"	Penwortham	4	2.7 ±*1.7*	-	-	*	1.2 ±*2.0*	*	510 ±*8.1*	-	2.3 ±*2.4*
Terrestrial samples											
Milk	Near farms	5	-	-	-	-	-	-	-	-	-
"	Far farms	1	-	-	-	-	-	-	-	-	-
Blackberries[e,f]		1	<0.6	0.30 ±*0.04*	-	<3.3	<1.1	-	-	<0.20	<0.4
Carrots		1	<0.5	<0.20	-	<3.8	<1.2	-	-	<0.20	<0.5
Cauliflower/Lettuce		1	-	-	-	-	-	-	-	-	-
Duck[f]		1	<0.4	<0.20	-	<3.9	<0.8	-	-	3.2 ±*0.3*	<0.5
Potatoes[e,f]		1	<0.3	<0.20	-	<2	<0.9	-	-	<0.20	<0.3
Runner Beans		1	-	<0.20	-	-	-	-	-	<0.20	-
Bovine Faeces		3	-	-	-	-	-	-	-	-	-
"	max										
Ovine Faeces		2	-	-	-	-	-	-	-	-	-
"	max										
Grass		4	-	-	-	-	-	-	-	-	-
"	max										
Sileage		4	-	-	-	-	-	-	-	-	-
"	max										
Soil		4	-	-	-	-	-	-	-	-	-
"	max										
Dry cloths		135	-	-	-	-	-	-	-	-	-

Table 20(a). continued

Material	Location[b] or selection[c]	No. of sampling observations[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
			^{155}Eu	^{228}Th	^{230}Th	^{232}Th	^{234}Th	^{233}Pa	^{234}U	^{235}U+ ^{236}U	^{238}U	Total U
Aquatic samples												
Flounder	Ribble Estuary	1	*	-	-	-	*	*	-	-	-	-
Salmon	"	1	*	-	-	-	*	*	-	-	-	-
Sea trout	"	1	*	-	-	-	*	*	-	-	-	-
Shrimps	"	1	*	-	-	-	*	*	-	-	-	-
Turf	Hesketh Bank	4	3.1 ±*1.1*	-	-	-	300 ±*19*	*	-	-	-	-
Mud	Becconsall	4	1.5 ±*0.9*	24 ±*1.0*	-	20 ±*0.6*	30000 ±*100*	*	15 ±*0.5*	*	12 ±*0.5*	-
"	Pipelines	4	*	26 ±*1.9*	-	22 ±*1.3*	60000 ±*150*	*	31 ±*1.0*	1.5 ±*0.2*	23 ±*0.8*	-
Mud & sand	"	4	*	11 ±*0.4*	-	9.2 ±*0.3*	220000 ±*250*	*	93 ±*3.1*	5.5 ±*0.3*	76 ±*2.6*	-
"	Deepdale Brook	4	3.5 ±*1.3*	24 ±*1.0*	-	20 ±*0.6*	1100	8.6 ±*3.9*	1000 ±*25*	46 ±*1.7*	940 ±*23*	-
Mud	Savick Brook	4	2.2 ±*1.4*	31 ±*2.1*	-	24 ±*1.3*	350000	*	-	-	-	-
"	Penwortham	4	3.4 ±*1.7*	31 ±*1.1*	-	24 ±*0.7*	120000 ±*200*	*	34 ±*1.2*	1.7 ±*0.2*	25 ±*1.0*	-
Terrestrial samples												
Milk	Near farms	5	-	-	-	-	-	-	-	-	-	<0.0064
"	Far farms	1	-	-	-	-	-	-	-	-	-	<0.0064
Blackberries[c,f]		1	<0.7	-	<0.0050	<0.0050	-	-	-	-	-	-
Carrots		1	<0.6	-	0.011 ±*0.006*	<0.0050	-	-	-	-	-	-
Cauliflower/Lettuce		1	-	-	0.19 ±*0.04*	0.14 ±*0.03*	-	-	-	-	-	0.44 ±*0.04*
Duck[f]		1	<0.6	-	<0.0050	<0.0050	-	-	-	-	-	-
Potatoes[c,f]		1	<0.4	-	<0.0050	<0.0050	-	-	-	-	-	-
Runner Beans		1	-	-	-	-	-	-	-	-	-	-
Bovine faeces		3	-	-	-	-	-	-	-	-	-	1.8 ±*0.1*
"	max											2.7 ±*0.1*
Ovine faeces		2	-	-	-	-	-	-	-	-	-	9.6 ±*0.4*
"	max											*10* ±*0.4*
Grass		4	-	-	-	-	-	-	-	-	-	2.8 ±*0.2*
"	max											6.4 ±*0.3*
Sileage		4	-	-	-	-	-	-	-	-	-	0.72 ±*0.08*
"	max											1.2 ±*0.1*
Soil		4	-	-	-	-	-	-	-	-	-	150 ±*11*
"	max											290 ±*15*
Dry cloths		135	-	-	-	-	-	-	-	-	-	-

Table 20(a). continued

Material	Location[b] or selection[c]	No. of sampling observa-tions[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}								
			^{237}Np	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic samples											
Flounder	Ribble Estuary	1	-	-	-	*	-	-	-	-	-
Salmon	"	1	-	-	-	*	-	-	-	-	-
Sea trout	"	1	-	-	-	*	-	-	-	-	-
Shrimps	"	1	-	-	-	*	-	-	-	-	-
Turf	Hesketh Bank	4	-	-	-	210 *±5.9*	-	-	-	-	-
Mud	Becconsall	4	-	-	-	150 *±4.9*	-	-	-	-	-
"	Pipeline	4	-	22 *±0.9*	120 *±3.1*	190 *±5.0*	*	0.32 *±0.11*	-	1600	-
Mud & sand	"	4	-	-	-	64 *±5.8*	-	-	-	-	-
"	Deepdale Brook	4	3.5 *±0.4*	-	-	*	-	-	-	-	-
Mud	Savick Brook	4	-	25 *±1.1*	140 *±3.4*	230 *±6.4*	0.24 *±0.21*	*	-	-	-
"	Penwortham	4	0.77 *±0.12*	-	-	210 *±9.7*	-	-	-	-	-
Terrestrial samples											
Milk	Near farms	5	-	-	-	-	-	-	-	-	-
"	Far farms	1	-	-	-	-	-	-	-	-	-
Blackberries[c,f]		1	-	<0.00020	0.00030 *±0.00020*	<0.00020	-	-	-	-	-
Carrots		1	-	-	-	-	-	-	-	-	-
Cauliflower/Lettuce		1	-	-	-	-	-	-	-	-	-
Duck[f]		1	-	0.00040 *±0.00040*	0.0023 *±0.0008*	0.0030 *±0.0012*	-	-	-	-	-
Potatoes[c,f]		1	-	<0.00030	<0.00040	<0.00050	-	-	-	-	-
Runner Beans		1	-	-	-	-	-	-	-	-	-
Bovine Faeces		3	-	-	-	-	-	-	-	-	-
"	max										
Ovine Faeces		2	-	-	-	-	-	-	-	-	-
"	max										
Grass		4	-	-	-	-	-	-	-	-	-
"	max										
Sileage		4	-	-	-	-	-	-	-	-	-
"	max										
Soil		4	-	-	-	-	-	-	-	-	-
"	max										
Dry cloths		135	-	-	-	-	-	-	1.0 *±1.4*	1.8 *±6.9*	4.6 *±12*

\- *not analysed*
* *not detected by the method used*
[a] *Except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment and uranium in soil where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *Data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition*
[d] *See section 5 for definition*
[e] *The concentration of ^{129}I was <0.050 Bq kg^{-1}*
[f] *The concentration of ^{241}Pu was <0.10 Bq kg^{-1}*

Table 20(b). Monitoring of radiation dose rates near Springfields, 1995

Location	Material or ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Lytham - Boatyard	Mud	4	0.11
" - Windmill Marsh	Salt marsh	1	0.12
" (boat 1)	Cabin[b]	2	0.082
Warton Marsh	Mud	4	0.14
"	" [c]	4	0.15
"	Salt marsh	4	0.14
The Naze	"	1	0.14
Banks marsh	Mud	4	0.15
"	" [c]	4	0.16
Salt marsh	4		0.18
Hesketh Bank	Mud	4	0.12
"	" [c]	4	0.13
"	Salt marsh	4	0.13
Freckleton	Mud	4	0.12
River Douglas	Grass	1	0.20
Becconsall	Mud	4	0.10
" (boat 1)	Cabin[b]	1	0.088
" (boat 2)	"	14	0.088
" "	Mud	10	0.12
" (boat 4)	Cabin[b]	1	0.066
Hutton Marsh	Mud	4	0.17
"	Salt marsh	4	0.17
Pipeline	Mud	3	0.12
"	Mud and sand	1	0.10
Pipeline (south bank)	Mud	1	0.11
"	Mud and sand	3	0.12
"	Salt marsh	4	0.17
Savick Brook - tidal limit	Mud	3	0.20
" - A583 bridge	"	4	0.20
" - confluence with Ribble	"	3	0.18
" "	Mud and sand	1	0.12
Penwortham	Mud	3	0.17
"	Mud and sand	1	0.096
Lower Penwortham	Mud	3	0.15
"	Mud and sand	1	0.089
"	Grass	4	0.081
Penwortham Railway Bridge	Mud	3	0.14
"	Sand and stones	1	0.081
"	Grass	4	0.084
River Darwen	Mud	2	0.10
"	Mud, sand and stones	1	0.086
"	Grass	3	0.089
Beta dose rates			µSv h^{-1}
Lytham - Windmill Marsh	Salt marsh	1	1.0
" - Boatyard	Mud	4	4.8
Warton Marsh	"	4	3.0
"	Salt marsh	4	1.5
The Naze	"	1	1.3
Banks Marsh	Mud	4	2.7
"	Salt marsh	4	1.5
Hesketh Bank	Mud	4	3.5
"	Salt marsh	4	1.4
Freckleton	Mud	4	9.8
River Douglas	Grass	1	1.1
Deepdale Brook	Mud and sand	4	0.67
Becconsall	Mud	4	6.3
Hutton Marsh	"	4	1.6
"	Salt marsh	4	2.2
Pipeline	Mud	3	22
"	Mud and sand	1	3.1
Pipeline (south bank)	Mud	1	9.7
"	Mud and sand	3	4.6
"	Salt marsh	4	1.6
Savick Brook - tidal limit	Mud	3	24
" "	Mud and sand	1	0.69
" - A583 bridge	Mud	4	78
" - confluence with Ribble	"	3	33
" "	Mud and sand	1	8.3
Penwortham	Mud	3	33
"	Mud and sand	1	0.85
Lower Penwortham	Mud	3	15
"	Mud and sand	1	0.41
"	Grass	4	3.3
Penwortham Railway Bridge	"	4	1.4
"	Mud	3	17
"	Sand and stones	1	0.35
River Darwen	Mud	2	5.4
"	Mud, sand and stones	1	17
"	Grass	4	3.2
Ribble estuary	Gill net	2	0.47
"	Shrimp net	2	0.35

[a] *See section 5 for definition*
[b] *In the cabin of a houseboat*
[c] *15 cm above substrate*

Table 21. Radioactivity in food and the environment near Capenhurst, 1995

Material	Location or selection[c]	No. of sampling observations	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																			
			^{3}H	^{60}Co	^{99}Tc	^{137}Cs	^{155}Eu	^{234}Th	^{233}Pa	^{234}U	$^{235+236}$U	^{238}U	Total U	^{237}Np	^{238}Pu	$^{239+240}$Pu	^{241}Am	^{242}Cm	$^{243+244}$Cm	Total alpha	Total beta	Total gamma
Aquatic samples																						
Shrimps	Hoylake	2	-	*	4.7 *±0.2*	2.8 *±0.1*	*	*	-	-	-	-	-	-	-	-	*	-	-	-	-	-
Cockles	Dee estuary	4	-	0.13 *±0.08*	60 *±4.7*	2.9 *±0.2*	*	0.85 *±1.1*	*	-	-	-	-	-	0.16 *±0.01*	0.85 *±0.03*	2.1 *±0.07*	0.005 *±0.004*	0.007 *±0.003*	-	-	-
Cladophoraceae sp.	Rivacre Brook	1	-	*	350 *±27*	0.58 *±0.13*	0.53 *±0.27*	150	21	35 *±2.3*	1.8 *±0.3*	27 *±1.9*	-	10 *±0.9*	-	-	*	-	-	-	530	-
Elodea canadensis	"	2	-	0.06 *±0.03*	270 *±24*	0.98 *±0.06*	0.18 *±0.14*	140	20	-	-	-	-	8.5 *±0.8*	-	-	*	-	-	-	720	-
Mud	"	1	-	*	1700 *±130*	13 *±0.6*	8	590	130	-	-	-	-	48 *±4.3*	-	-	*	-	-	-	-	-
Mud & sand	"	1	-	*	200 *±16*	5.7 *±0.4*	*	59	12	66 *±4.0*	3.9 *±0.7*	40 *±2.7*	-	6.4 *±0.6*	-	-	*	-	-	-	-	-
Freshwater	"	2	350 *±2.4*	-	6.6 *±0.7*	-	-	-	-	0.34 *±0.02*	0.024 *±0.003*	0.32 *±0.02*	-	0.024 *±0.002*	-	-	-	-	-	-	-	-

Material	Location or selection[c]	No. of sampling observations	Mean radioactivity concentration (wet)[a], Bq kg^{-1}				
			^{99}Tc	Total U	Total alpha	Total beta	Total gamma
Terrestrial samples							
Milk	Near farms	1	<0.040	<0.0064	-	-	-
"	Far farms	1	<0.040	<0.0064 *±0.0013*	-	-	-
Celery		1	<0.10	<0.026	-	-	-
Potatoes		1	<0.10	0.12 *±0.03*	-	-	-
Strawberries		1	<0.10	<0.0066	-	-	-
Grass/Faeces		4	<0.10	-	-	-	-
Bovine faeces		8	-	2.0 *±0.3*	-	-	-
"	max			5.2 *±0.8*			
Grass		8	-	<0.10 *±0.03*	-	-	-
"	max			0.16 *±0.05*			
Silage		4	-	0.45 *±0.07*	-	-	-
"	max			1.3 *±0.1*			
Soil		4	-	53 *±6.9*	-	-	-
"	max			57 *±7.3*			
Dry cloths		128	-	-	0.20 *±0.17*	1.2 *±0.8*	0.62 *±0.45*

\- *not analysed*
* *not detected by the method used*
[a] *Except for milk and water where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for soil and sediment where dry concentrations apply*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'Max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*

Table 22(a). Radioactivity in food and the environment near Harwell, 1995

Material	Location or selection[c]	No. of sampling observa-tions	Mean radioactivity concentration (wet)[a], Bq kg^{-1}															
			^{3}H	^{57}Co	^{51}Cr	^{60}Co	^{65}Zn	^{90}Sr	^{134}Cs	^{137}Cs	^{155}Eu	^{238}Pu	$^{239+240}$Pu	^{241}Am	$^{243+244}$Cm	Total alpha	Total beta	Total gamma
Aquatic samples																		
Pike	Outfall (Sutton Courtenay)	1	-	*	*	*	*	0.0083 *±0.0035*	0.008 *±0.07*	7.1 *±0.1*	*	0.000027 *±0.000008*	0.00016 *±0.00003*	0.00015 *±0.00003*	*	-	-	-
"	Newbridge	1	-	*	*	*	*	0.0091 *±0.0036*	*	0.05 *±0.03*	*	0.000046 *±0.000016*	0.00020 *±0.00003*	0.00023 *±0.00004*	*	-	-	-
"	Staines	1	-	*	*	*	*	-	*	0.31 *±0.08*	*	-	-	*	-	-	-	-
Nuphar lutea	Outfall (Sutton Courtenay)	1	-	*	2.3 *±1.6*	0.75 *±0.14*	*	-	*	1.6 *±0.1*	*	-	-	*	-	-	-	-
"	Newbridge	1	-	*	*	*	*	-	*	*	*	-	-	*	-	-	-	-
"	Staines	1	-	0.15 *±0.02*	*	*	0.13 *±0.06*	-	*	0.18 *±0.02*	*	-	-	*	-	-	310	-
Mud & Sand	Staines	1	-	0.67 *±0.21*	*	1.8 *±0.5*	*	-	*	22 *±0.8*	2.0 *±0.7*	-	-	2.4 *±1.9*	-	-	1000	-
	Outfall (Sutton Courtenay)	2	-	*	*	11 *±1.1*	*	-	*	570 *±4.7*	*	-	-	*	-	-	-	-
Mud	Newbridge	1	-	*	*	*	*	-	*	8.6 *±0.5*	2.1 *±1.2*	0.11 *±0.008*	1.1 *±0.04*	0.45 *±0.03*	0.0023 *±0.0013*	-	-	-
"	Lydebank/Ginge Brook confluence	1	-	*	*	3.0 *±0.4*	*	-	*	25 *±0.6*	1.0 *±0.6*	-	-	-	-	-	-	-

Material	Location or selection[c]	No. of sampling observa-tions	Mean radioactivity concentration (wet)[a], Bq kg^{-1}						
			^{3}H	^{60}Co	^{134}Cs	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples									
Milk[d]	Near farms	4	<10	<0.46	<0.33	<0.44	-	-	-
"	Far farms	1	<10	<0.53	<0.3	<0.43	-	-	-
Apples		1	33 *±5.0*	<0.3	<0.2	<0.5	-	-	-
Elderberries		1	18 *±4.0*	<1	<0.7	<0.9	-	-	-
Honey		1	<10	<0.5	<0.4	<0.4	-	-	-
Potatoes		1	<10	<0.5	<0.4	<0.4	-	-	-
Rhubarb		1	31 *±5.0*	<0.5	<0.4	<0.6	-	-	-
Runner beans		1	<10	<0.5	<0.4	<0.4	-	-	-
Dry cloths		95	-	-	-	-	0.21 *±0.15*	0.79 *±0.52*	0.67 *±0.46*

- not analysed
** not detected by the method used*
[a] Except for milk where units are Bq l^{-1} and for sediment where dry concentrations apply
[b] See section 5 for definition
[c] Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.
[d] The concentration of ^{3}H (organic) was <10 Bq l^{-1}

Table 22(b). Monitoring of radiation dose rates near Harwell, 1995

Location	Ground type	No. of sampling observa-tions[a]	μGy h^{-1}
Gamma dose rates at 1 m over river bank			
Outfall (Sutton Courtenay)	Mud	1	0.083
"	Soil	1	0.085
Position 'E'[b]	Mud	1	0.096
"	Soil	1	0.093
Lydebank/Ginge Brook confluence	Mud	1	0.058
"	Mud and sand	1	0.053
Newbridge	Mud	1	0.065

[a] See section 5 for definition
[b] Near the outfall

Table 23(a). Radioactivity in food and the environment near Winfrith, 1995

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}												
			^{3}H	^{14}C	^{60}Co	^{131}I	^{137}Cs	^{155}Eu	^{238}Pu	^{239}Pu + ^{240}Pu	^{241}Am	^{243}Cm + ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic samples															
Plaice	Weymouth Bay	1	-	-	*	*	0.20 *±0.11*	*	-	-	*	-	-	-	-
Cod	"	1	-	-	*	*	0.29 *±0.05*	*	-	-	*	-	-	-	-
Crabs	Chapman's Pool	1	-	-	1.3 *±0.1*	*	*	*	-	-	*	-	-	-	-
"	Lulworth Banks	1	-	-	3.1 *±0.2*	*	*	*	-	-	*	-	-	-	-
Pacific Oysters	Poole	1	-	-	0.28 *±0.06*	*	0.10 *±0.05*	*	-	-	*	-	-	-	-
Cockles	"	1	-	-	1.8 *±0.1*	*	0.06 *±0.03*	*	-	-	*	-	-	-	-
Whelks	Weymouth Bay	1	-	-	1.1 *±0.2*	*	*	*	-	-	*	-	-	-	-
"	Poole	1	-	-	1.2 *±0.2*	*	*	*	0.0013 *±0.0001*	0.0061 *±0.0003*	0.008 *±0.0004*	0.00010 *±0.00003*	-	-	-
Fucus serratus	Kimmeridge	2	-	-	2.0 *±0.2*	*	*	*	-	-	*	-	-	220	-
"	Bognor Rock	2	-	-	1.9	0.59 *±0.1*	0.09 *±0.19*	0.05 *±0.04*	- *±0.06*	-	*	-	-	-	-
Mud & sand	Kimmeridge	2	-	-	1.7 *±0.4*	*	1.1 *±0.4*	0.38 *±0.38*	-	-	*	-	-	-	-
"	Parkstone Bay	2	-	-	2.1 *±0.6*	*	0.75 *±0.40*	*	0.063 *±0.005*	0.32 *±0.01*	0.25 *±0.01*	0.0025 *±0.00083*	-	-	-
Mud	Hardway	2	-	-	8.5 *±0.6*	*	3.7 *±0.4*	0.83 *±0.80*	-	-	*	-	-	-	-

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}						
			^{3}H	^{14}C	^{60}Co	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples									
Milk	Near farms[e]	4	<10	17 *±3.4*	<0.44	<0.44	-	-	-
"	" max			19 *±3.5*					
"	Far farms[e]	1	<10	16 *±3.5*	<0.45	<0.43	-	-	-
Apples		1	<10	15 *±5.0*	<0.4	<0.4	-	-	-
Cabbage[e]		1	<10	<15	<0.5	<0.4	-	-	-
Carrots		1	<10	<15	<0.3	<0.5	-	-	-
Honey		1	<10	59 *±16*	<0.8	0.60 *±0.20*	-	-	-
Lettuce[e]		1	<10	-	-	-	-	-	-
Potatoes		1	<10	22 *±6.0*	<0.4	<0.4	-	-	-
Raspberries		1	<10	15 *±3.0*	<0.4	<0.4	-	-	-
Grass[e]		4	<11 *±3.5*	-	-	-	-	-	-
Dry cloths		106	-	-	-	-	0.10 *±0.10*	0.59 *±0.50*	0.32 *±0.24*

- not analysed
** not detected by the method used*
[a] Except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dryconcentrations apply
[b] Landing point or sampling area.
[c] See section 5 for definition
[d] Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5
[e] The concentration of ^{3}H (organic) was <10 Bq l^{-1}

Table 23(b). Monitoring of radiation dose rates near Winfrith, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Kimmeridge	Mud and sand	2	0.070
Parkstone Bay	Mud	2	0.052
Hardway	"	2	0.065

[a] See section 5 for definition

Table 24(a). Radioactivity in food and the environment near Berkeley and Oldbury nuclear power stations, 1995

Material	Location or selection[c]	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}														
			^{3}H	^{14}C	^{35}S	^{60}Co	^{134}Cs	^{137}Cs	^{144}Ce	^{155}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Am	^{243}Cm+ ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic samples																	
Dover sole	Lydney	2	-	210 *±9*	-	*	*	0.42 *±0.08*	*	*	-	-	*	-	-	-	-
Elvers	Littleton Warth	1	-	-	-	*	*	0.09 *±0.03*	*	*	-	-	*	-	-	-	-
Shrimps	Lydney	2	-	120 *±7*	-	*	*	0.28 *±0.05*	*	*	0.00018 *±0.00003*	0.0010 *±0.0001*	0.0010 *±0.0001*	0.000009 *±0.000006*	-	-	-
Fucus vesiculosus	Pipeline[e]	2	-	-	-	0.12 *±0.04*	*	0.82 *±0.06*	*	0.17 *±0.12*	-	-	*	-	-	170	-
Mud	"	2	-	-	-	*	0.75 *±0.42*	22 *±0.6*	*	1.6 *±0.7*	-	-	*	-	-	-	-
"	Lydney	2	-	-	-	0.21 *±0.16*	0.75 *±0.43*	31 *±0.5*	*	2.2 *±0.7*	-	-	*	-	-	-	-
"	Hills Flats	2	-	-	-	0.27 *±0.25*	0.49 *±0.48*	31 *±0.7*	1.1 *±1.0*	2.2 *±0.7*	-	-	*	-	-	-	-
"	1km south of Oldbury	2	-	-	-	0.22 *±0.24*	0.21 *±0.33*	30 *±0.7*	*	2.5 *±1.0*	-	-	*	-	-	-	-

Material	Location or selection[c]	No. of sampling observ-ations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
			^{3}H	^{14}C	^{35}S	^{60}Co	^{134}Cs	^{137}Cs	^{144}Ce	Total alpha	Total beta	Total gamma
Terrestrial samples												
Milk[d]	Near farms	8	<10	17 *±3.1*	<1.0	<0.23	<0.24	<0.23	<1.08	-	-	-
"	" max			20 *±3.0*								
Apples		1	<10	<15	<1.0	<0.4	<0.2	<0.4	<1.3	-	-	-
Blackberries		1	<10	29 *±5.0*	<1.0	<0.6	<0.3	<0.5	<2	-	-	-
Cabbage		1	<10	<15	<1.0	<0.3	<0.2	<0.3	<1	-	-	-
Carrots		1	<10	16 *±4.0*	<1.0	<0.4	<0.4	<0.4	<1.7	-	-	-
Honey		1	<10	73 *±16*	<1.0	<0.4	<0.4	<0.4	<1.6	-	-	-
Potatoes		1	<10	22 *±5.0*	<1.0	<0.4	<0.3	<0.6	<2.3	-	-	-
Runner Beans		1	<10	37 *±5.0*	<1.0	<0.3	<0.4	<0.5	<1	-	-	-
Wheat		1	<10	100 *±18*	<1.0	<0.6	<0.4	<0.4	<2.5	-	-	-
Dry cloths		168	-	-	-	-	-	-	-	0.15 *±0.16*	0.79 *±0.54*	0.49 *±0.38*

- not analysed
** not detected by the method used*
[a] *Except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'Max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*
[d] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*
[e] *Berkeley*

Table 24(b). Monitoring of radiation dose rates near Berkeley and Oldbury nuclear power stations, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
1 km south of Oldbury	Mud	2	0.086
2 km south west of Berkeley	"	2	0.065
Guscar Rocks	"	2	0.083
Lydney Locks	"	2	0.069
Berkeley pipeline (new)	"	1	0.089
"	Shale	1	0.097
Sharpness	Mud	2	0.073
Hills Flats	"	1	0.070
"	Salt marsh	1	0.073

[a] *See section 5 for definition*

Table 25(a). Radioactivity in food and the environment near Bradwell nuclear power station, 1995

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																	
			^{3}H	^{14}C	^{35}S	^{60}Co	^{65}Zn	^{99}Tc	^{125}Sb	^{134}Cs	^{137}Cs	^{55}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic Samples																				
Sole	Bradwell	2	-	-	*	*	*	-	*	*	0.84 *±0.12*	*	-	-	*	-	-	-	-	-
Bass	Pipeline	1	-	-	-	*	*	-	*	0.48 *±0.10*	2.2 *±0.1*	*	-	-	*	-	-	-	-	-
Mullet	"	1	-	-	-	*	*	-	*	0.39 *±0.09*	1.9 *±0.1*	*	-	-	*	-	-	-	-	-
Native oysters	Tollesbury N Channel	2	-	13 *±5.4*	*	0.04 *±0.03*	1.5 *±0.1*	-	*	0.10 *±0.06*	0.35 *±0.05*	*	0.00042 *±0.00004*	0.0017 *±0.0001*	0.0048 *±0.0002*	0.000041 *±0.000002*	0.00030 *±0.00003*	-	-	-
Pacific oysters	Goldhanger Creek	1	-	-	-	0.44 *±0.07*	1.7 *±0.2*	-	*	*	0.44 *±0.07*	*	-	-	*	-	-	-	-	-
Winkles	Pipeline	2	-	-	-	0.78 *±0.10*	0.98 *±0.21*	-	*	0.14 *±0.08*	0.59 *±0.09*	*	-	-	*	-	-	-	-	-
Fucus vesiculosus	Waterside	2	-	-	-	0.63 *±0.09*	*	2.5 *±0.2*	*	0.30 *±0.08*	1.4 *±0.1*	*	-	-	*	-	-	-	-	-
Mud	Pipeline	2	-	-	-	5.0 *±0.5*	0.25 *±0.15*	-	0.62 *±0.59*	2.4 *±0.6*	19 *±0.6*	1.4 *±0.8*	-	-	0.55 *±0.38*	-	-	-	230	-
"	West Mersea	2	-	-	-	1.3 *±0.4*	*	-	*	1.8 *±0.6*	16 *±0.7*	1.1 *±0.6*	-	-	*	-	-	-	-	-
"	Maldon	2	-	-	-	4.9 *±0.7*	*	-	*	6.7 *±0.8*	64 *±12*	1.9 *±1.1*	-	-	0.48 *±0.65*	-	-	-	-	-

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}								
			^{3}H	^{14}C	^{35}S	^{60}Co	^{134}Cs	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples											
Milk	Near farms[d]	3	<10	17 *±3.3*	<1.0	<0.44	<0.35	<0.43	-	-	-
"	" max			18 *±3.3*							
"	Far farms[d]	3	<10	17 *±3.4*	<1.0	<0.43	<0.2	<0.3	-	-	-
"	" max			19 *±3.8*							
Apples		2	<10	<18 *±2.8*	1.6 *±1.0*	<0.45	<0.5	<0.5	-	-	-
"	max			20 *±4.0*	2.1 *±1.2*						
Blackberries		1	<10	28 *±6.0*	<1.0	<0.3	<0.3	<0.4	-	-	-
Cabbage		1	<10	<15	<1.0	<0.5	<0.3	<0.5	-	-	-
Leeks		1	<10	<15	<1.0	<0.9	<0.5	<0.7	-	-	-
Potatoes		1	<10	25 *±4.0*	<1.0	<0.3	<0.2	<0.3	-	-	-
Rabbit		1	<10	29 *±6.0*	<3.0	<0.5	<0.2	<0.3	-	-	-
Wheat		1	<10	89 *±14*	<1.0	<0.5	<0.2	<0.4	-	-	-
Lucerne		1	<10	21 *±6.0*	1.3 *±0.6*	<0.5	<0.4	<0.5	-	-	-
Dry cloths		120	-	-	-	-	-	-	0.23 *±0.16*	1.4 *±1.0*	0.9 *±0.61*

- not analysed
** not detected by the method used*
[a] Except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply
[b] See section 5 for definition
[c] Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5
[d] The concentration of ^{3}H (organic) was < 10 Bq l^{-1}

Table 25(b). Monitoring of radiation dose rates near Bradwell, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Pipeline	Mud	2	0.24
1.5 km east of pipeline	"	1	0.072
Waterside	"	2	0.063
West Mersea	"	2	0.064
Maldon	"	2	0.057

[a] See section 5 for definition

Table 26(a). Radioactivity in food and the environment near Dungeness nuclear power stations, 1995

Material	Location or selection[c]	No. of sampling observ- ations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																
			^{3}H	^{14}C	^{35}S	^{90}Sr	^{60}Co	^{131}I	^{134}Cs	^{137}Cs	^{155}Eu	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Am	^{242}Cm	$^{243}Cm+^{244}Cm$	Total alpha	Total beta	Total gamma
Aquatic samples																			
Plaice	Pipeline	2	-	-	-	-	*	*	*	0.20 *±0.10*	*	-	-	*	-	-	-	-	-
Cod	"	2	-	-	-	-	*	*	*	0.28 *±0.07*	*	-	-	*	-	-	-	-	-
Bass	"	1	-	-	-	-	*	*	*	0.65 *±0.15*	*	-	-	*	-	-	-	-	-
Spiny spider crabs	Hastings	1	-	-	-	-	1.4 *±0.4*	*	*	*	*	-	-	*	-	-	-	-	-
Shrimps	Pipeline	2	-	28 *±10*	-	-	0.12 *±0.08*	*	0.06 *±0.04*	0.31 *±0.09*	*	-	-	*	-	-	-	-	-
Whelks	"	2	-	-	-	0.014 *±0.004*	0.42 *±0.08*	*	*	0.05 *±0.04*	*	0.0010 *±0.0001*	0.0036 *±0.0002*	0.0049 *±0.0002*	0.00002 *±0.00002*	0.00059 *±0.00053*	-	-	-
Fucus vesiculosus	Copt Point	2	-	-	-	-	0.73 *±0.09*	0.09 *±0.07*	*	0.15 *±0.07*	*	-	-	*	-	-	-	200	-
Mud & sand	Rye Harbour	1	-	-	-	-	3.7 *±0.5*	*	*	1.8 *±0.3*	*	0.080 *±0.007*	0.38 *±0.02*	0.27 *±0.01*	0.0018 *±0.0015*	0.019 *±0.003*	-	-	-
Sand	Camber Sands	2	-	-	-	-	1.0 *±0.3*	*	*	0.14 *±0.12*	*	-	-	*	-	-	-	-	-
"	Pilot Inn	2	-	-	-	-	1.7 *±0.3*	*	*	0.94 *±0.19*	0.66 *±0.53*	-	-	*	-	-	-	-	-
Sea water	Pipeline	2	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Material	Location or selection[c]	No. of sampling observ- ations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}												
			^{3}H	^{14}C	^{35}S	^{90}Sr	^{60}Co	^{131}I	^{134}Cs	^{137}Cs	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Am	Total alpha	Total beta	Total gamma
Terrestrial samples																
Milk[f]	Far farms[d]	2	<10	<23 *±3.9*	<1.0	-	<0.45	<0.33	*	<0.45	-	-	-	-	-	-
"	" " max			<24 *±4.0*												
"	" " sub-sets[d]	1	-	-	-	-	<0.3	<0.10	<0.3	<0.30	-	-	-	-	-	-
Barley		1	<10	87 *±13*	<1.0	-	<0.6	-	<0.4	<0.40	-	-	-	-	-	-
Blackberries[d]		1	<10	27 *±6.0*	<1.0	-	<0.5	-	<0.3	<0.40	-	-	-	-	-	-
Green Beans[d]		1	<10	<15	<1.0	-	<0.3	-	<0.4	<0.50	-	-	-	-	-	-
Honey		1	<10	65 *±17*	<1.0	-	<0.5	-	<0.4	<0.40	-	-	-	-	-	-
Potatoes[d]		1	<10	14 *±3.0*	<1.0	-	<0.2	-	<0.2	<0.30	-	-	-	-	-	-
Sea Kale[d]		1	<10	14 *±3.0*	2.2 *±0.6*	-	<0.4	-	<0.2	1.1 *±0.1*	-	-	-	-	-	-
Ovine Muscle[d]		1	<10	26 *±10*	<3.0	<0.20	<0.4	-	-	<0.20[e]	<0.0002	<0.0002	<0.0005	-	-	-
Ovine Offal[d]		1	<10 *±6.0*	30	<3.0 *±0.05*	0.73	<0.4	-	-	0.29[e] *±0.07*	<0.0002	<0.0002	<0.0003	-	-	-
Dry cloths		96	-	-	-	-	-	-	-	-	-	-	-	0.34 *±0.27*	1.9 *±1.3*	1.2 *±0.82*

- not analysed
** not detected by the method used*
[a] *Except for milk and seawater where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*
[d] *The concentration of ^{3}H (organic) was 10 Bq l^{-1}*
[e] *Total Cs*
[f] *There are no farms producing milk near this site*

Table 26(b). Monitoring of radiation dose rates near Dungeness nuclear power stations, 1995

Location	Ground type	No. of sampling observa- tions[a]	μGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Camber Sands	Sand	2	0.052
Old Lifeboat Station	Stones	2	0.045
Pilot Inn	Sand	2	0.055
Rye Harbour	Mud and sand	2	0.064
Beta dose rates			μSv h^{-1}
Rye Harbour	Mud and sand	1	*

[a] *See section 5 for definition*
** Not detected by the method used*

Table 27(a). Radioactivity in food and the environment near Hartlepool nuclear power station, 1995

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}														
			^{3}H	^{14}C	^{35}S	^{99}Tc	^{131}I	^{137}Cs	^{155}Eu	^{238}Pu	^{239}Pu + ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm + ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic samples																	
Plaice	Pipeline	2	-	31 *±7.7*	-	-	*	0.38 *±0.05*	*	-	-	*	-	-	-	-	-
Cod	"	2	-	-	-	-	*	1.2 *±0.1*	*	-	-	*	-	-	-	-	-
Crabs	"	2	-	-	-	-	*	0.26 *±0.12*	*	0.00030 *±0.00003*	0.0018 *±0.0001*	0.0015 *±0.0001*	*	*	-	-	-
Winkles	South Gare	2	-	-	-	-	*	0.40 *±0.09*	*	0.0093 *±0.0004*	0.051 *±0.001*	0.034 *±0.001*	0.000054 *±0.000039*	0.000056 *±0.000022*	-	-	-
Fucus vesiculosus	Pilot Station	2	-	-	-	30 *±2.4*	15 *±0.8*	0.51 *±0.07*	*	-	-	*	-	-	-	250	-
Mud	Greatham Creek	2	-	-	-	-	*	12 *±0.6*	2.6 *±0.8*	-	-	*	-	-	-	-	-
"	Paddy's Hole	2	-	-	-	-	*	22 *±1.1*	1.0 *±1.0*	-	-	*	-	-	-	-	-
Coal & sand	Little Scar	2	-	-	-	-	*	2.3 *±0.3*	0.69 *±0.44*	-	-	*	-	-	-	-	-
Sea water	Pipeline	2	16 *±1.8*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}							
			^{3}H	^{14}C	^{35}S	^{131}I	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples										
Milk	Near farms[e]	1	<10	20 *±4.0*	<1.0 *±0.5*	<0.20	<0.5	-	-	-
"	" sub-sets	1	-	-	-	<0.10	<0.3	-	-	-
"	Far farms[e]	4	<10	<18 *±3.8*	<1.0	<0.20	<0.44	-	-	-
"	" max			20 *±3.7*						
"	" sub-sets	2	-	-	-	<0.10	-	-	-	-
Cabbage[e]		3	<10	<15	<1.0	-	<0.45	-	-	-
"	sub-sets	1	-	-	-	-	<0.3	-	-	-
Cauliflower[e]		1	<10	<15	<1.0	-	<0.7	-	-	-
Honey		1	<10	78 *±20*	<1.0	-	<0.6	-	-	-
Potatoes[e]		1	<10	21 *±5.0*	<1.0	-	<0.4	-	-	-
Sloe Berries[e]		1	<10	24 *±5.0*	<1.0	-	<0.4	-	-	-
Swede[e]		1	<10	<15	<1.0	-	<0.5	-	-	-
Wheat		1	<10	120 *±21*	<1.0	-	<0.4	-	-	-
Dry cloths		120	-	-	-	-	-	0.37 *±0.36*	1.7 *±1.2*	1.2 *±1.0*

- *not analysed*
* *not detected by the method used*
[a] *Except for milk and seawater where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *See section 5 for definition*
[d] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*
[e] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*

Table 27(b). Monitoring of radiation dose rates near Hartlepool nuclear power station, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Greatham Creek	Mud and sand	2	0.072
Little Scar	Coal and sand	2	0.054
North Gare	Sand	2	0.055
Paddy's Hole	Mud	2	0.086
Beta dose rates			µSv h^{-1}
Little Scar	Coal and sand	2	0.099

[a] *See section 5 for definition*

Table 28(a). Radioactivity in food and the environment near Heysham nuclear power stations, 1995

Material	Location[b] or selection[c]	No. of sampling observ-ations[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																
			^{3}H	^{14}C	^{35}S	^{54}Mn	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{110m}Ag	^{125}Sb	^{131}I	^{134}Cs	^{137}Cs	^{154}Eu	^{155}Eu	^{238}Pu	^{239}Pu+^{240}Pu
Aquatic samples																			
Flounder	Flookburgh	4	-	87 ±*8.8*	-	*	*	-	-	*	*	*	-	0.02 ±*0.03*	32 ±*0.7*	*	*	0.00064 ±*0.00004*	0.0033 ±*0.0001*
Plaice	Morecambe	5	-	-	-	*	*	-	-	*	*	*	-	0.03 ±*0.06*	10 ±*0.3*	*	*	-	-
Bass	"	2	-	-	-	*	*	-	-	*	*	*	-	*	29 ±*0.4*	*	*	-	-
Whitebait	Sunderland Point	1	-	-	-	*	*	0.15 ±*0.03*	-	*	*	*	-	*	8.4 ±*0.2*	*	*	0.024 ±*0.001*	0.13 ±*0.004*
Cockles	Middleton Sands	2	-	-	-	*	1.0 ±*0.1*	-	-	1.3 ±*0.5*	*	0.18 ±*0.12*	-	*	4.6 ±*0.1*	0.08 ±*0.11*	0.06 ±*0.06*	0.34 ±*0.02*	1.8 ±*0.1*
"	Flookburgh	2	-	110 ±*8.1*	-	*	0.98 ±*0.07*	0.71 ±*0.05*	26 ±*2.0*	2.0 ±*0.4*	*	0.24 ±*0.15*	-	*	6.1 ±*0.1*	0.24 ±*0.14*	*	0.65 ±*0.03*	3.4 ±*0.1*
Winkles	Red Nab Point	4	-	-	-	*	0.49 ±*0.08*	-	-	1.6 ±*0.7*	0.83 ±*0.14*	0.35 ±*0.15*	-	*	5.1 ±*0.1*	*	*	0.31 ±*0.02*	1.8 ±*0.1*
Shrimps	Flookburgh	4	-	110 ±*10*	-	*	*	0.12 ±*0.02*	21 ±*1.7*	*	*	*	-	*	10 ±*0.3*	*	*	0.0048 ±*0.0003*	0.025 ±*0.001*
Mussels	Morecambe	4	-	110 ±*9.0*	-	*	0.44 ±*0.08*	-	250 ±*20*	1.6 ±*0.6*	*	0.35 ±*0.16*	-	*	3.0 ±*0.1*	*	0.05 ±*0.1*	0.29 ±*0.02*	1.5 ±*0.04*
"	NW Morecambe Bay	2	-	-	-	*	0.39 ±*0.11*	-	-	0.92 ±*0.45*	*	0.23 ±*0.14*	-	*	4.1 ±*0.2*	*	0.09 ±*0.09*	0.25 ±*0.01*	1.3 ±*0.04*
"	" [e]	1	-	-	-	*	0.40 ±*0.08*	-	-	2.2 ±*0.7*	*	0.40 ±*0.15*	-	*	3.3 ±*0.1*	*	*	-	-
Fucus vesiculosus	Half Moon Bay	4	-	-	-	*	0.53 ±*0.10*	-	10000 ±*830*	*	*	0.89 ±*0.29*	-	*	12 ±*0.2*	*	0.06 ±*0.06*	-	-
Samphire	Cockerham Marsh	1	-	-	-	*	0.02 ±*0.02*	-	-	*	*	*	-	*	3.6 ±*0.1*	*	*	-	-
Mud & sand	Flookburgh	4	-	-	-	*	*	-	-	*	*	*	-	*	110 ±*1.6*	*	0.50 ±*0.59*	-	-
"	Half Moon Bay	3	-	-	-	0.20 ±*0.25*	4.6 ±*0.6*	-	-	17 ±*6.3*	*	2.7 ±*1.6*	-	0.29 ±*0.39*	250 ±*2.4*	2.3 ±*1.2*	2.7 ±*1.7*	14 ±*0.6*	71 ±*1.6*
"	Sunderland Point	4	-	-	-	*	2.9 ±*0.7*	-	-	11 ±*5.8*	*	1.7 ±*1.5*	-	0.35 ±*0.60*	210 ±*2.4*	0.83 ±*1.1*	2.5 ±*1.2*	-	-
"	Morecambe Central Pier	4	-	-	-	*	2.9 ±*0.8*	-	-	19 ±*6.7*	*	1.5 ±*1.2*	-	*	230 ±*2.6*	2.4 ±*1.5*	2.0 ±*1.7*	-	-
Turf	Conder Green	4	-	-	-	*	2.0 ±*1.1*	-	-	*	*	3.4 ±*3.1*	-	0.51 ±*0.83*	590 ±*8.0*	2.3 ±*3.1*	3.0 ±*3.2*	-	-
"	Sand Gate Marsh	4	-	-	-	*	1.0 ±*0.8*	-	-	*	*	*	-	*	250 ±*3.7*	*	*	-	-
Mud	Half Moon Bay	1	-	-	-	*	4.1 ±*0.5*	-	-	17 ±*5.1*	*	4.0 ±*1.7*	-	*	270 ±*2.2*	2.4 ±*1.0*	2.2 ±*1.3*	-	-
Sea water	Pipeline	2	11 ±*2.1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
"	Half Moon Bay	1	-	-	-	-	-	-	-	-	-	0.004 ±*0.002*	0.38 ±*0.002*	-	-	-	-	-	-
Terrestrial samples																			
Milk	Near farms[f]	8	<10 ±*0.9*	<18 ±*3.6*	<1.0	-	<0.4	-	-	<3.22	<0.54	-	<0.20	<0.35	<0.44	-	-	-	-
"	" max		<11 ±*2.5*	21 ±*4.1*											<0.48				
"	" sub-sets	2	-	-	-	-	<0.3	-	-	<1.78	<0.35	-	<0.10	<0.25	<0.30	-	-	-	-
"	Far farms[f]	2	<10	<16 ±*3.2*	<1.0	-	<0.4	-	-	<3.43	<0.56	-	-	<0.33	<0.44	-	-	-	-
"	" max			<17 ±*3.3*											<0.45				
Apples[f]		1	<10	16 ±*3.0*	<1.0	-	<0.5	-	-	<3.2	<0.2	-	-	<0.3	<0.40	-	-	-	-
Barley		1	<10	70 ±*18*	<1.0	-	<0.5	-	-	<3.8	<0.6	-	-	<0.4	<0.40	-	-	-	-
Blackberries[f]		1	<10	<15	<1.0	-	<0.7	-	-	<4	<1.4	-	-	<0.9	<1.0	-	-	-	-
Cabbage[f]		1	<10	13 ±*3.0*	<1.0	-	<0.3	-	-	<2	<0.3	-	-	<0.2	<0.30	-	-	-	-
Potatoes[f]		1	<10	17 ±*4.0*	<1.0	-	<0.6	-	-	<3.9	<0.6	-	-	<0.4	<0.50	-	-	-	-
Sprouts[f]		1	<10	15 ±*4.0*	<1.0	-	<0.6	-	-	<3.9	<0.6	-	-	<0.6	<0.80	-	-	-	-
Dry cloths		95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 28(a). continued

Material	Location[b] or selection[c]	No. of sampling observa-tions[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}						
			^{241}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total alpha	Total beta	Total gamma
Aquatic samples									
Flounder	Flookburgh	1	-	0.0045 *±0.0001*	*	0.000011 *±0.000004*	-	-	-
Plaice	Morecambe	5	-	*	-	-	-	-	-
Bass	"	2	-	*	-	-	-	-	-
Whitebait	Sunderland Point	1	1.5 *±0.2*	0.18 *±0.001*	*	*	-	-	-
Cockles	Middleton Sands	2	-	4.9 *±0.1*	*	0.011 *±0.004*	-	-	-
"	Flookburgh	2	41 *±1.2*	8.4 *±0.2*	*	0.015 *±0.007*	-	-	-
Winkles	Red Nab Point	4	-	2.9 *±0.1*	*	0.0057 *±0.0026*	-	-	-
Shrimps	Flookburgh	4	0.62 *±0.36*	0.039 *±0.001*	*	0.000068 *±0.000037*	-	-	-
Mussels	Morecambe	4	-	2.6 *±0.1*	*	0.0072 *±0.0028*			
"	NW Morecambe Bay	2	-	2.3 *±0.1*	*	0.0049 *±0.0022*	-	-	-
"	" [e]	1	-	2.2 *±0.2*	-	-	-	-	-
Fucus vesiculosus	Half Moon Bay	4	-	1.0 *±0.3*	-	-	-	6900	-
Samphire	Cockerham Marsh	1	-	1.4 *±0.1*	-	-	-	44	-
Mud & sand	Flookburgh	4	-	39 *±2.7*	-	-	-	-	-
"	Half Moon Bay	3	-	110 *±3.3*	*	0.099 *±0.073*			
"	Sunderland Point	4	-	87 *±3.6*	-	-	-	-	-
"	Morecambe Central Pier	4	-	150 *±5.0*	-	-	-	-	-
Turf	Conder Green	4	-	230 *±11*	-	-	-	-	-
"	Sand Gate Marsh	4	-	82 *±4.6*	-	-	-	-	-
Mud	Half Moon Bay	1	-	140 *±3.2*	-	-	-	-	-
Sea water	Pipeline	2	-	-	-	-	-	-	-
"	Half Moon Bay	1	-	-	-	-	-	-	-
Terrestrial samples									
Milk	Near farms[f]	8	-	-	-	-	-	-	-
"	" max								
"	" sub-sets	2	-	-	-	-	-	-	-
"	Far farms[f]	2	-	-	-	-	-	-	-
"	" max								
Apples[f]		1	-	-	-	-	-	-	-
Barley		1	-	-	-	-	-	-	-
Blackberries[f]		1	-	-	-	-	-	-	-
Cabbage[f]		1	-	-	-	-	-	-	-
Potatoes[f]		1	-	-	-	-	-	-	-
Sprouts[f]		1	-	-	-	-	-	-	-
Dry cloths		95	-	-	-	-	0.18 *±0.18*	1.0 *±0.9*	0.58 *±0.42*

- *not analysed*
* *not detected by the method used*
[a] *Except for milk and seawater where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *Landing point or sampling area.*
[c] *Data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.*
[d] *See section 5 for definition*
[e] *Uncooked sample*
[f] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*

Table 28(b). Monitoring of radiation dose rates near Heysham nuclear power stations, 1995

Location	Ground type	No. of sampling observa-tions[a]	μGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Greenodd	Salt marsh	2	0.086
Sand Gate marsh	"	4	0.11
Flookburgh	Mud and sand	4	0.075
High Foulshaw	Salt marsh	4	0.094
Arnside	Mud and sand	4	0.069
"	Salt marsh	4	0.11
Morecambe Central Pier	Mussel bed	4	0.078
"	Mud	2	0.078
"	Mud and sand	2	0.086
Half Moon Bay	"	4	0.082
Pipeline	"	4	0.075
Red Nab Point	Mud and sand	4	0.080
Sunderland Point	"	4	0.086
Sunderland	Mud, sand and stones	4	0.080
Colloway Marsh	Salt marsh	4	0.16
Lancaster	"	4	0.11
Aldcliffe Marsh	"	4	0.14
Conder Green	Mud	1	0.096
"	Mud and sand	3	0.10
"	Salt marsh	4	0.13
Cockerham Marsh	Salt marsh	4	0.11

[a] *See section 5 for definition*

Table 29(a). Radioactivity in food and the environment near Hinkley Point nuclear power stations, 1995

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																	
			^{3}H	^{14}C	^{35}S	^{54}Mn	^{60}Co	^{65}Zn	^{95}Zr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	^{155}Eu	^{238}Pu	^{239}Pu+^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+^{244}Cm	Total beta
Aquatic samples																				
Flounder	Stolford	2	-	110 *±9.4*	*	*	*	*	*	*	0.05 *±0.03*	0.66 *±0.14*	*	*	-	-	*	-	-	-
Shrimps	"	2	-	83 *±8.0*	*	*	*	*	*	*	0.13 *±0.05*	0.65 *±0.06*	*	*	0.00044 *±0.00004*	0.0017 *±0.0001*	0.0021 *±0.0001*	0.00038 *±0.00007*	0.000063 *±0.00002*	-
Fucus vesiculosus	Pipeline	2	-	-	-	2.9 *±0.1*	3.4 *±0.1*	0.58 *±0.17*	*	*	1.6 *±0.1*	6.4 *±0.2*	0.74 *±0.54*	*	-	-	*	-	-	240
Mud & sand	"	2	-	-	-	0.71 *±0.50*	1.5 ±0.4	*	*	*	4.1 *±0.7*	19 *±0.8*	3.5 *±2.4*	*	-	-	*	-	-	-
"	River Parrett	2	-	-	-	0.43 *±0.3*	0.21 *±0.30*	*	*	*	2.5 *±0.7*	40 *±1.0*	*	1.8 *±1.3*	-	-	*	-	-	-
Mud	1.6km east of pipeline	2	-	-	-	*	0.52 *±0.33*	*	0.90 *±1.0*	*	3.4 *±1.0*	31 *±1.1*	*	1.9	-	-	*	-	-	-
Sea water	Pipeline	2	380 *±5.3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Material	Location[b] or selection[d]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}											
			^{3}H	^{14}C	^{35}S	^{60}Co	^{95}Zr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	Total alpha	Total beta	Total gamma
Terrestrial samples														
Milk	Near farms[e]	7	<10	<19 *±3.5*	<1.0	<0.44	<1.36	<0.20	<0.31	<0.4	<1.71	-	-	-
"	" max			<28 *±4.5*										
"	" sub-sets	2	-	-	-	<0.3	<1.1	<0.10	<0.2	<0.27	<1.02	-	-	-
"	Far farms[e]	2	<10	<18 *±3.5*	<1.0	<0.44	<1.44	-	<0.33	<0.42	<2.04	-	-	-
"	" max			<20 *±3.7*										
Apples[e]		1	<10	16 *±4.0*	<1.0	<0.4	<0.9	-	<0.2	<0.4	<1.5	-	-	-
Blackberries[e]		1	<10	28 *±4.0*	<1.0	<0.4	<0.7	-	<0.3	<0.4	<1.7	-	-	-
Honey		1	<10	93 *±13*	<1.0	<0.5	<1.7	-	<0.4	<0.5	<1.4	-	-	-
Kale[e]		1	<10	16 *±3.0*	<1.0	<0.5	<1.7	-	<0.2	<0.5	<2.6	-	-	-
Leeks[e]		1	<10	<15	<1.0	<0.6	<2.4	-	<0.4	<0.7	<0.9	-	-	-
Potatoes[e]		1	<10	39 *±5.0*	2.5 *±0.5*	<0.3	<0.6	-	<0.2	<0.3	<1	-	-	-
Wheat		1	<10	110 *±13*	14 *±1.4*	<0.6	<0.8	-	<0.3	<0.5	<2	-	-	-
Fodder Beet[e]		1	<10	19 *±5.0*	<1.0	<0.5	<0.5	-	<0.3	<0.5	<2	-	-	-
Dry cloths		107	-	-	-	-	-	-	-	-	-	0.28 *±0.24*	1.5 *±0.98*	1.1 *±0.73*

- not analysed
** not detected by the method used*
[a] *Except for milk and seawater where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *Landing point or sampling area.*
[c] *See section 5 for definition*
[d] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*
[e] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*

Table 29(b). Monitoring of radiation dose rates near Hinkley Point nuclear power stations, 1995

Location	Ground type	No. of sampling observa-tions[a]	μGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
0.8 km east of pipeline	Mud	1	0.059
"	Mud and sand	1	0.097
0.8 km west of pipeline	Mud	1	0.23
"	Mud and sand	1	0.21
1.6 km east of pipeline	Mud	1	0.068
"	Mud and sand	1	0.083
Pipeline	Mud	1	0.11
"	Mud and sand	1	0.11
River Parrett	Mud	1	0.079
"	Mud and sand	1	0.070

[a] *See section 5 for definition*

Table 30(a). Radioactivity in food and the environment near Sizewell nuclear power stations, 1995

Material	Location[b] or selection[c]	No. of sampling observ-ations[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}														
			^{3}H	^{14}C	^{35}S	^{58}Co	^{60}Co	^{65}Zn	^{137}Cs	^{155}Eu	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Am	$^{243}Cm+^{244}Cm$	Total alpha	Total beta	Total gamma
Aquatic samples																	
Cod	Sizewell	1	-	-	-	*	*	*	0.69 *±0.08*	*	-	-	*	-	-	-	-
Dover sole	"	1	-	-	-	*	*	*	0.43 *±0.19*	*	-	-	*	-	-	-	-
Shrimps	"	1	-	-	-	*	*	*	0.89 *±0.19*	*	0.00029 *±0.00006*	0.0015 *±0.0002*	0.0025 *±0.0002*	*	-	-	-
Crabs	"	2	-	30 *±11*	-	0.08 *±0.07*	0.13 *±0.08*	*	0.26 *±0.07*	*	0.00021 *±0.00004*	0.0012 *±0.0001*	0.0025 *±0.0001*	0.00006 *±0.00020*	-	-	-
Pacific oysters	Blyth estuary	1	-	-	-	*	*	0.13 *±0.08*	0.21 *±0.05*	*	-	-	*	-	-	-	-
Whelks	Dunwich	1	-	-	-	*	0.16 *±0.10*	*	*	*	-	-	*	-	-	-	-
Mud	Southwold	2	-	-	-	0.52 *±0.26*	3.6 *±0.7*	*	14 *±1.0*	0.83 *±0.68*	-	-	*	-	-	760	-
Sand	Rifle Range	2	-	-	-	*	*	*	0.37 *±0.16*	*	-	-	*	-	-	-	-
"	Aldeburgh	2	-	-	-	*	*	*	0.30 *±0.15*	*	-	-	*	-	-	-	-
Sea water	"	2	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Material	Location[b] or selection[c]	No. of sampling observ-ations[d]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}							
			^{3}H	^{14}C	^{35}S	^{60}Co	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples										
Milk[e]	Near farms	3	<10	<17 *±3.5*	<1.0	<0.43	<0.44	-	-	-
"	" max			<18 *±3.3*		<0.53	<0.48	-	-	-
"	" sub-sets	1	-	-	-	<0.23	<0.23	-	-	-
"	Far farms	4	<10	<18 *±3.2*	<1.0	<0.46	<0.46	-	-	-
"	" max			20 *±3.3*		<0.50	<0.50	-	-	-
Apples		1	<10	14 *±4.0*	<1.0	<0.40	<0.40	-	-	-
Blackberries		1	<10	<15	1.1 *±0.8*	<0.40	<0.40	-	-	-
Cabbage		1	<10	<15	<1.0	-	-	-	-	-
"	sub-sets	1	-	-	-	<0.30	<0.30	-	-	-
Carrots		1	<10	12 *±3.0*	<1.0	<0.30	<0.40	-	-	-
Honey		1	<10	79 *±18*	<1.0	<0.50	<0.60	-	-	-
Potatoes		1	<10	22 *±3.0*	<1.0	<0.40	<0.40	-	-	-
Runner Beans		1	<10	<15	<1.0	<0.40	<0.40	-	-	-
Wheat		1	<10	91 *±12*	<1.1	<0.60	<0.50	-	-	-
Dry cloths		117	-	-	-	-	-	0.21 *±0.16*	1.2 *±0.99*	0.94 *±0.88*

- not analysed
** not detected by the method used*
[a] Except for milk and seawater where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply
[b] Landing point or sampling area.
[c] Data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.
[d] See section 5 for definition
[e] The concentration of ^{3}H (organic) was <10 Bq l^{-1}

Table 30(b). Monitoring of radiation dose rates near Sizewell nuclear power station, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
Pipeline	Sand	2	0.14
Dunwich	"	2	0.045
Rifle range	"	2	0.045
Sizewell Hall	"	2	0.046
Aldeburgh	Sand and gravel	2	0.045
Southwold Harbour	Mud	2	0.062
Beta dose rates			µSv h^{-1}
Southwold Harbour	Mud	2	0.23

[a] See section 5 for definition

Table 31(a). Radioactivity in food and the environment near Trawsfynydd nuclear power station, 1995

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}															
			^{3}H	^{14}C	^{35}S	^{60}Co	^{90}Sr	^{106}Ru	^{125}Sb	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu	^{155}Eu	^{238}Pu	$^{239+240}$Pu	^{241}Pu	^{241}Am
Freshwater samples																		
Brown trout	Lake	6	-	30 ±*8.4*	*	*	7.8 ±*0.1*	*	*	9.1 ±*0.4*	140 ±*1.4*	*	*	*	0.00013 ±*0.00002*	0.00037 ±*0.00003*	-	0.00054 ±*0.00004*
Rainbow trout	"	6	-	-	*	*	0.68 ±*0.01*	*	*	0.45 ±*0.21*	6.4 ±*0.4*	*	*	*	0.000077 ±*0.000014*	0.00029 ±*0.00002*	-	0.00054 ±*0.00004*
"	Hatchery	1	-	-	-	*	-	*	*	0.39 ±*0.15*	5.6 ±*0.2*	*	*	*	-	-	-	*
Perch	Lake	4	-	-	*	*	4.7 ±*0.1*	*	*	20 ±*1.2*	330 ±*3.4*	*	*	*	0.00020 ±*0.00002*	0.00060 ±*0.00004*	-	0.0010 ±*0.00006*
Rudd	"	1	-	-	-	*	-	*	*	21 ±*0.9*	310 ±*2.9*	*	*	*	-	-	-	*
Fontinalis	Afon Prysor	2	-	-	-	*	-	*	*	0.22 ±*0.24*	11 ±*0.5*	*	*	1.4 ±*0.5*	-	-	-	*
"	Gwylan Stream	2	-	-	-	25 ±*1.2*	-	18 ±*5.9*	31 ±*2.0*	4.9 ±*1.0*	100 ±*1.6*	*	2.0 ±*1.5*	4.6 ±*0.8*	-	-	-	3.7 ±*0.4*
Mud	Pipeline (bankside)	2	-	-	-	47 ±*2.9*	-	130 ±*23*	85 ±*11*	140 ±*3.9*	2100 ±*12*	47 ±*11*	16 ±*4.3*	11 ±*5.1*	-	-	-	40 ±*5.1*
"	Hot lagoon	2	-	-	-	97 ±*8.9*	-	86 ±*66*	330 ±*36*	150 ±*9.7*	6100 ±*42*	23 ±*19*	37 ±*15*	20 ±*9.7*	40 ±*3.5*	100 ±*6.6*	2200 ±*100*	160 ±*5.1*
"	Barrier wall	2	-	-	-	130 ±*6.9*	-	280 ±*58*	700 ±*28*	230 ±*7.8*	6500 ±*28*	76 ±*24*	51 ±*11*	31 ±*12*	-	-	-	180 ±20
"	South end of lake	3	-	-	-	2.1 ±*0.5*	-	3.0 ±*4.7*	13 ±*3.9*	24 ±*1.4*	920 ±*5.0*	*	*	2.4 ±*1.6*	-	-	-	2.2 ±*2.0*
Mud, sand and stones	Gwylan Stream	2	-	-	-	6.9 ±*1.1*	-	*	37 ±*6.7*	40 ±*1.9*	1500 ±*8.5*	*	*	*	-	-	-	*
Peat	Below Maentwrog power station	1	-	-	-	670 ±*10*	-	520 ±*48*	770 ±*21*	160 ±*7.4*	3200 ±*18*	110 ±*22*	64 ±*8.6*	46 ±*11*	-	-	-	120 ±*20*
Water	Bailey bridge	4	2.1 ±*1.7*	-	-	-	-	-	-	0.010 ±*0.003*	0.091 ±*0.003*	-	-	-	-	-	-	-
"	Cold lagoon	4	-	-	-	-	-	-	-	0.0064 ±*0.0030*	0.067 ±*0.002*	-	-	-	-	-	-	-
"	Afon Prysor	2	-	-	-	-	-	-	-	*	0.0060 ±*0.0014*	-	-	-	-	-	-	-
Terrestrial samples																		
Milk	Near farms[d]	1	<10	16 ±*3.3*	<1.0	<0.5	<0.20	<2.5	<0.75	-	<0.22[e] ±*0.01*	<2.25	<0.45	<0.7	<0.0002	<0.0002	<0.1	<0.0002
"	sub-sets	1	-	-	-	<0.2	0.082 ±*0.009*	<1.7	<0.5	<0.2	<0.3 ±*0.07*	<1.25	<0.3	<0.4	-	-	-	-
"	Far farms[d]	1	<10	17 ±*2.9*	<1.0	<0.4	<0.20	<3.38	<0.8	-	<0.24[e] ±*0.02*	<1.8	<0.43	<0.58	<0.0002	<0.0002	<0.1	<0.0002
Blackberries		1	<10	16 ±*3.0*	<1.0	<0.4	-	<2.8	<0.7	<0.3	1.2 ±*0.1*	<1.7	<0.5	<0.6	<0.0002	<0.0002	-	0.0003 ±*0.0003*
Cabbage		1	<10	<15	<1.0	<0.6	-	<1.8	<0.8	<0.3	<0.50	<1.7	<0.6	<0.6	<0.0002	0.0004 ±*0.0003*	-	<0.0007
Eggs		1	<10	20 ±*4.0*	<1.0	<0.4	-	<3.1	<0.8	<0.3	<0.40	<1.4	<0.4	<0.6	<0.0002	<0.0002	-	0.0003 ±*0.0003*
Hazelnuts		1	<10	66 ±*9.0*	<1.0	<0.5	-	<3.8	<1.6	<0.6	6.9 ±*0.4*	<1.6	<0.4	<0.5	<0.0002	<0.0002	-	<0.0002
Ovine muscle		2	<10	30 ±*8.0*	<3.0	<0.65	<0.2	<3.8	<1.7	-	9.2[e] ±*0.6*	<2.65	<0.6	<0.85	<0.0002	<0.0002	-	<0.0003 ±*0.0002*
"	Max			32 ±*8.0*							15[e] ±*0.8*							
Ovine offal		2	<10	43 ±*8.5*	<3.0	<0.5	0.44 ±*0.05*	<3.9	<1.1	-	14[e] ±*0.8*	<2.45	<0.45	<0.65	-	-	-	-
"	Max			44 ±*8.0*			0.63 ±*0.05*				22[e] ±*1.1*							
Potatoes		1	<10	32 ±*8.0*	<1.0	<0.4	-	<1.9	<0.6	<0.3	0.30 ±*0.10*	<1.3	<0.4	<0.4	<0.0002	0.0014 ±*0.0004*	-	0.0006 ±*0.0003*
Spinach		1	<10	<15	<1.0	<0.4	-	<2.2	<0.9	<0.3	<0.50	<1.6	<0.4	<0.6	<0.0002	0.0006 ±*0.0003*	-	0.0007 ±*0.0005*
Grass[d]		2	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dry cloths		123	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 31(a). continued

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}				
			^{242}Cm	$^{243+244}$Cm	Total alpha	Total beta	Total gamma
Freshwater samples							
Brown trout	Lake	6	*	0.000019 ±*0.000006*	-	-	-
Rainbow trout	"	6	*	0.000010 ±*0.000004*	-	-	-
"	Hatchery	1	-	-	-	-	-
Perch	Lake	4	0.000009 ±*0.000008*	0.000029 ±*0.000008*	-	-	-
Rudd	"	1	-	-	-	-	-
Fontinalis	Afon Prysor	2	-	-	-	-	-
"	Gwylan Stream	2	-	-	-	-	-
Mud	Pipeline (bankside)	2	-	-	-	-	-
"	Hot lagoon	2	0.67 ±*0.33*	5.3 ±*0.7*	-	7100	-
"	Barrier wall	2	-	-	-	-	-
"	South end of lake	3	-	-	-	-	-
Mud, sand and stones	Gwylan Stream	2	-	-	-	-	-
Peat	Below Maentwrog power station	1	-	-	-	-	-
Water	Bailey bridge	4	-	-	-	-	-
"	Cold lagoon	4	-	-	-	-	-
"	Afon Prysor	2	-	-	-	-	-
Terrestrial samples							
Milk	Near farms[d]	1	-	-	-	-	-
"	sub-sets	1	-	-	-	-	-
"	Far farms[d]	1	-	-	-	-	-
Blackberries		1	-	-	-	-	-
Cabbage		1	-	-	-	-	-
Eggs		1	-	-	-	-	-
Hazelnuts		1	-	-	-	-	-
Ovine muscle		2	-	-	-	-	-
"	max						
Ovine offal		2	-	-	-	-	-
"	max						
Potatoes		1	-	-	-	-	-
Spinach		1	-	-	-	-	-
Grass[d]		2					
Dry cloths		123	-	-	0.29 ±*0.29*	1.6 ±*1.2*	0.63 ±*0.37*

- not analysed
** not detected by the method used*
[a] *Except for milk and water where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition*
[d] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*
[e] *Total Cs*

Table 31(b). Monitoring of radiation dose rates near Trawsfynydd nuclear power station, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over areas near lake shoreline			
Bailey Bridge	Peat	2	0.081
"	Rock	1	0.092
South end of lake	Peat	4	0.081
"	Mud	1	0.085
"	Stones	1	0.088
Cae Adda boat mooring	Peat	3	0.071
Footbridge	Rock	1	0.10
Nant Islyn Bay	Mud, sand and stones	1	0.094
West of footbridge	Stones	1	0.099

[a] *See section 5 for definition*

Table 32(a). Radioactivity in food and the environment near Wylfa nuclear power station, 1995

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																
			^{3}H	^{14}C	^{35}S	^{60}Co	^{65}Zn	^{99}Tc	^{110m}Ag	^{125}Sb	^{137}Cs	^{238}Pu	$^{239+240}Pu$	^{241}Pu	^{241}Am	$^{243+244}Cm$	Total alpha	Total beta	Total gamma
Aquatic samples																			
Plaice	Pipeline	2	-	31 *±9.1*	-	*	*	-	*	*	1.8 *±0.1*	-	-	-	*	-	-	-	-
Crabs	"	2	-	-	-	0.017 *±0.01*	*	1.3 *±0.1*	0.69 *±0.11*	*	0.55 *±0.08*	0.0050 *±0.0003*	0.023 *±0.001*	-	0.18 *±0.006*	*	-	-	-
Winkles	Cemaes Bay	2	-	-	-	*	0.32 *±0.31*	-	*	*	1.6 *±0.2*	0.060 *±0.003*	0.32 *±0.007*	4.4 *±0.5*	0.41 *±0.01*	0.0011 *±0.0005*	-	-	-
Fucus vesiculosus	"	2	-	-	-	*	*	-	*	0.17 *±0.15*	1.8 *±0.1*	-	-	-	*	-	-	710	-
Mud	Cemlyn Bay	2	-	-	-	*	*	-	*	*	180 *±3.1*	4.2 *±0.3*	23 *±0.8*	-	33 *±0.9*	0.061 *±0.027*	-	-	-
Seawater	Cemaes Bay	1	-	-	-	-	-	-	-	-	0.01 *±0.01*	-	-	-	-	-	-	-	-

Material	Location or selection[c]	No. of sampling observa-tions[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}								
			^{3}H	^{14}C	^{35}S	^{60}Co	^{110m}Ag	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples											
Milk	Near farms[d]	5	<10	<17 *±3.4*	<1.1 *±0.2*	<0.46	<0.56	<0.44	-	-	-
"	" max			19 *±3.6*	<1.3 *±0.4*			<0.50			
"	" sub-sets	2	-	-	-	<0.28	<0.3	<0.30	-	-	-
"	Far farms[d]	1	<10	17 *±3.3*	<1.0	<0.48	<0.58	<0.45	-	-	-
Apples		1	<10	18 *±5.0*	<1.0	<0.4	<0.5	<0.40	-	-	-
Barley		1	<10	110 *±15*	4.6 *±0.4*	<0.6	<0.4	<0.40	-	-	-
Blackberries		1	<10	13 *±4.0*	<1.0	<0.4	<0.4	<0.40	-	-	-
Cabbage		1	<10	<15	<1.0	<0.8	<1	<0.80	-	-	-
Carrots		1	<10	<15	<1.0	<0.5	<0.5	<0.50	-	-	-
Goats milk		2	<10	19 *±3.5*	<1.0	<0.45	<0.5	<0.40	-	-	-
"	max			21 *±4.0*							
Mushrooms		1	<10	<15	<1.0	<0.8	<1	<0.70	-	-	-
Potatoes		1	<10	23 *±5.0*	<1.0	<0.6	<0.6	<0.50	-	-	-
Runner beans		1	<10	<15	<1.0	<0.7	<0.8	<0.70	-	-	-
Dry cloths		94	-	-	-	-	-	-	0.28 *±0.20*	1.7 *±0.9*	0.66 *±0.46*

\- *not analysed*
* *not detected by the method used*
[a] *Except for milk and sea water where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5*
[d] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*

Table 32(b). Monitoring of radiation dose rates near Wylfa nuclear power station, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m intertidal areas			
Cemaes Bay	Sand	4	0.053
Cemlyn Bay	Mud	4	0.078

[a] *See section 5 for definition*

Table 33(a). Radioactivity in food and the environment near Aldermaston, 1995

Material	Location or selection[c]	No. of sampling observations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}										
			^{57}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{137}Cs	^{155}Eu	^{238}Pu	$^{239+240}$Pu	^{241}Am	Total beta
Aquatic samples													
Pike	Newbridge	1	*	*	*	0.0091 *±0.0036*	*	0.05 *±0.03*	*	0.000046 *±0.000016*	0.00020 *±0.00003*	0.00023 *±0.00004*	-
"	Outfall (Pangbourne)	1	*	*	*	-	*	0.59 *±0.06*	*	0.000085 *±0.000022*	0.00039 *±0.00003*	0.00036 *±0.00005*	-
"	Staines	1	*	*	*	-	*	0.31 *±0.08*	*	-	-	*	-
Nuphar lutea	Newbridge	1	*	*	*	-	*	*	*	-	-	*	-
"	Outfall (Pangbourne)	1	*	0.11 *±0.06*	*	-	*	0.14 *±0.04*	*	-	-	*	-
"	Staines	1	0.15 *±0.02*	*	0.13 *±0.06*	-	*	0.18 *±0.02*	*	-	-	*	-
Clay	Outfall (Pangbourne)	1	*	0.51 *±0.19*	*	-	*	0.15 *±0.30*	0.21 *±0.41*	-	-	*	430
Mud & sand	Staines	1	0.67 *±0.21*	1.8 *±0.5*	*	-	*	22 *±0.8*	2.0 *±0.7*	-	-	*	310
Mud	Foudry Brook	1	*	*	*	-	110 *±3.4*	5.6 *±0.5*	2.1 *±1.1*	-	-	*	-
"	Newbridge	1	*	*	*	-	*	8.6 *±0.5*	2.1 *±1.2*	-	-	*	-

Material	Location or selection[c]	No. of sampling observations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
			^{3}H	^{60}Co	^{137}Cs	Total U	^{238}Pu	$^{239+240}$Pu	^{241}Am	Total alpha	Total beta	Total gamma
Terrestrial samples												
Milk	Near farms[d]	4	<10	<0.475	<0.425	<0.0068 *±0.0007*	<0.0002	<0.0002	<0.0002	-	-	-
"	Max					<0.0078						
Apples		1	<10	<0.6	<0.4	0.011 *±0.003*	<0.0002	<0.0002	<0.0003	-	-	-
Blackberries		2	<10	<0.65	<0.75	<0.025 *±0.006*	<0.0002	<0.0002	<0.0005 *±0.0006*	-	-	-
"	Max					0.035 *±0.008*			0.0008 *±0.0008*			
Carrots		1	<10	<0.5	<0.4	0.050 *±0.015*	<0.0002	0.0002 *±0.0002*	0.0003 *±0.0003*	-	-	-
Honey		1	<10	<0.6	<0.6	<0.011	<0.0002	<0.0002	<0.0003	-	-	-
Lettuce		1	25 *±5.0*	<0.7	<0.7	0.56 *±0.04*	<0.0002	0.0012 *±0.0004*	0.0004 *±0.0003*	-	-	-
Potatoes		1	<10	<0.6	<0.5	0.044 *±0.006*	<0.0002	<0.0002	0.0003 *±0.0003*	-	-	-
Runner Beans		1	<10	<0.5	<0.4	<0.011	<0.0002	<0.0002	<0.0002	-	-	-
Wheat		1	<10	<0.5	<0.4	0.028 *±0.009*	<0.0002	<0.0002	0.0004 *±0.0003*			
Grass		4	-	-	-	-	0.002 *±0.0008*	0.053 *±0.006*	-	-	-	-
"	Max						0.0034 *±0.0011*	0.11 *±0.01*				
Soil		9	-	-	-	41 *±6.1*	0.0091 *±0.0042*	0.36 *±0.04*	-	-	-	-
"	Max					46 *±6.5*	0.016 *±0.008*	0.56 *±0.06*				
Dry cloths		94	-	-	-	-	-	-	-	0.18 *±0.22*	0.64 *±0.46*	0.45 *±0.30*

- not analysed
** not detected by the method used*
[a] Except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment and soil where dry concentrations apply
[b] See section 5 for definition
[c] Data are arithmetic means unless stated as 'max' in this column.'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.
[d] The concentration of ^{3}H (organic) was also <10 Bq l^{-1}

Table 33(b). Monitoring of radiation dose rates near Aldermaston, 1995

Location	Ground type	No. of sampling observations[a]	µGy h^{-1}
Gamma dose rates at 1 m over river bank			
Pangbourne	Grass	1	0.058
Newbridge	"	1	0.065

[a] see section 5 for definition

Table 34(a). Radioactivity in food and the environment near naval establishments, 1995

Material	Location[b]	No. of sampling observa-tions[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}											
			^{14}C	^{60}Co	^{106}Ru	^{125}Sb	^{131}I	^{137}Cs	^{154}Eu	^{155}Eu	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Am	$^{243}Cm+^{244}Cm$
Barrow														
Mud and sand	Walney channel (outfall)	2	-	3.7 *±1.1*	29 *±9.1*	2.7 *±2.6*	*	240 *±4.1*	2.6 *±1.1*	1.4 *±1.6*	-	-	160 *±6.3*	-
"	" (Vickerstown church)	4	-	3.9 ±0.7	32 *±6.7*	1.8 *±1.2*	*	190 *±3.0*	2.4 *±1.7*	2.1 *±1.5*	-	-	210 *±4.8*	-
Chatham														
Mud	Commodores Hard	1	-	3.2 *±0.6*	*	*	*	11 ±0.6	*	1.2 *±0.7*	-	-	*	-
"	Hoo Marina	1	-	2.8 *±0.7*	*	*	*	16 *±0.7*	*	1.8 *±1.3*	-	-	*	-
Devonport														
Dogfish	Plymouth Sound	1	-	*	*	*	*	0.37 *±0.11*	*	*	-	-	*	-
Crabs	"	1	28 *±10*	*	*	*	*	*	*	*	-	-	*	-
Fucus vesiculosus	Kinterbury	2	-	*	*	*	2.5 *±0.4*	0.16 *±0.08*	*	0.13 *±0.11*	-	-	*	-
Mud	"	2	-	0.16 *±0.22*	*	*	*	5.0 *±0.4*	*	2.2 *±1.1*	0.023 *±0.003*	0.39 ±0.01	0.13 *±0.009*	0.0012 *±0.0008*
"	Torpoint Ferry East		2	- *±0.33*	0.35	*	*	* *±0.6*	7.9	* *±0.55*	0.86	-	-	* -
"	Torpoint South	2	-	*	*	*	*	3.2 *±0.6*	*	0.80 *±0.70*	-	-	*	-
"	Calstock	1	-	*	*	*	6.1 *±1.2*	9.8 *±0.9*	*	*	-	-	*	-
"	Lopwell	2	-	0.23 *±0.20*	*	*	*	10 *±0.4*	* ±	1.5 *0.6*	-	-	*	-
"	Wilcove	1	-	0.48 *±0.31*	*	*	*	4.5 *±0.4*	*	1.6 *±0.9*	-	-	*	-

- not analysed
** not detected by the method used*
[a] Except for sediment where dry concentrations apply
[b] Landing point or sampling area
[c] See section 5 for definition

Table 34(b). Monitoring of radiation dose rates near naval establishments, 1995

Establishment	Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas				
Barrow	Walney Channel (1 km south of outfall)	Mud	1	0.10
"	" "	Mud and sand	3	0.081
"	" (Vickerstown church)	"	4	0.089
Chatham	Commodores Hard	Mud	1	0.053
"	Hoo Marina	"	1	0.056
"	Medway Yacht Club	"	1	0.056
Devonport	Kinterbury	"	2	0.073
"	Brunel Bridge East	"	2	0.074
"	Torpoint Ferry East	"	2	0.070
"	Stonehouse	"	2	0.070
"	Torpoint South	"	2	0.085
"	Calstock	"	1	0.094
"	Lopwell	"	2	0.079
"	Wilcove	"	1	0.083

[a] See section 5 for definition

Table 35(a). Radioactivity in food and the environment near Amersham, 1995

Material	Location or selection[c]	No. of sampling observations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}													
			^{14}C	^{57}Co	^{58}Co	^{60}Co	^{65}Zn	^{75}Se	^{90}Sr	^{131}I	^{137}Cs	^{155}Eu	^{238}Pu	$^{239+240}$Pu	^{241}Am	Total beta
Aquatic samples																
Pike	Newbridge	1	-	*	*	*	*	*	0.0091 *±0.0036*	*	0.05 *±0.03*	*	0.000046 *±0.000016*	0.00020 *±0.00003*	0.00023 *±0.00004*	-
"	Outfall (Grand Union Canal)	1	43 *±7.9*	0.05 *±0.02*	*	*	*	*	-	*	0.34	* *±0.07*	-	-	*	-
"	Staines	1	-	*	*	*	*	*	-	*	0.31 *±0.08*	*	-	-	*	-
Nuphar lutea	Newbridge	1	-	*	*	*	*	*	-	*	*	*	-	-	*	-
"	Outfall (Grand Union Canal)	1	-	0.37 *±0.02*	0.08 *±0.04*	*	0.37 *±0.08*	*	-	*	0.03 *±0.02*	*	-	-	*	-
"	Staines	1	-	0.15 *±0.02*	*	*	0.13 *±0.06*	*	-	*	0.18 *±0.02*	*	-	-	*	-
Mud	Outfall (Grand Union Canal)	1	-	11 *±0.4*	2.9 *±0.5*	0.54 *±0.26*	6.6 *±0.8*	*	-	*	8.9 *±0.5*	*	-	-	*	290
Mud & sand	Staines	1	-	0.67 *±0.21*	*	1.8 *±0.5*	*	*	-	*	22 *±0.8*	2.0 *±0.7*	-	-	*	310
Mud	Newbridge	1	-	*	*	*	*	*	-	*	8.6 *±0.5*	2.1 *±1.2*	-	-	*	-

Material	Location or selection[c]	No. of sampling observations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
			^{3}H	^{35}S	^{60}Co	^{75}Se	^{125}I	^{131}I	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples												
Milk	Near farms[d]	2	<10	<1.0	<0.41	<0.54	<0.050	<0.20	<0.41	-	-	-
"	" max					<0.55						
"	" sub-sets	2	-	-	<0.25	<0.40	-	<0.10	<0.3	-	-	-
"	Far farms[d]	1	<10	<1.0	<0.5	<0.55	<0.050	<0.20	<0.5	-	-	-
"	" sub-sets	1	-	-	<0.2	<0.35	-	-	<0.2	-	-	-
Apples		1	<10	<1.0	<0.3	<0.40	<0.069	-	<0.4	-	-	-
Beans		1	<10	1.1 *±0.6*	<0.7	<0.60	<0.072	-	<0.7	-	-	-
Blackberries		1	<10	<1.0	<0.3	<0.40	<0.089	-	<0.5	-	-	-
Cabbage		1	<10	<1.0	<0.4	<0.20	<0.18	-	<0.3	-	-	-
Wheat		1	<10	4.4 *±0.80*	<0.4	<0.40	0.30 *±0.23*	-	<0.5	-	-	-
Dry cloths		71	-	-	-	-	-	-	-	0.14 *±0.12*	0.71 *±0.40*	0.51 *±0.38*

- not analysed
** not detected by the method used*
[a] except for milk where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply
[b] See section 5 for definition
[c] Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.
[d] The concentration of ^{3}H (organic) was <10 Bq l^{-1}

Table 35(b). Monitoring of radiation dose rates near Amersham, 1995

Location	Ground type	No. of sampling observations[a]	μGy h^{-1}
Gamma dose rates at 1 m over river bank			
Grand Union Canal	Grass and concrete	1	0.049
Newbridge	Mud	1	0.065

[a] See section 5 for definition

Table 36(a). Radioactivity in food and the environment near Cardiff, 1995

Material	Location[b] or selection[c]	No. of sampling observa-tions	Mean radioactivity concentration (wet)[a], Bq kg^{-1}									
			^{3}H	^{14}C	^{35}S	^{57}Co	^{125}I	^{131}I	^{134}Cs	^{137}Cs	^{155}Eu	Total beta
Aquatic samples												
Flounder	East of new pipeline	3	-	650 *±13*	*	*	*	*	*	0.42 *±0.12*	*	-
Mussels	Orchard Ledges	2	-	510 *±8.7*	-	*	*	*	*	0.42 *±0.12*	*	-
Fucus vesiculosus	"	2	-	15 *±3.3*	-	*	*	3.2 *±0.3*	*	0.39 *±0.05*	0.07 *±0.06*	-
Fucus spiralis	East of new pipeline	2	-	15 *±2.9*	-	*	*	3.1 *±0.2*	*	0.31 *±0.04*	*	180
Mud	"	2	-	18 *±2.9*	-	*	*	*	*	15 *±0.6*	2.1 *±0.8*	-
"	West of new pipeline	2	-	31 *±2.8*	-	*	*	*	0.33 *±0.30*	20 *±0.5*	1.6 *±0.8*	-
Sea water	Orchard Ledges East	2	17 *±0.4*	-	-	-	-	-	-	-	-	-

Material	Location[b] or selection[c]		No. of sampling observa-tions	Mean radioactivity concentration (wet)[a], Bq kg^{-1}												
				^{3}H (organic)	^{3}H	^{14}C	^{32}P[e]	^{35}S	^{45}Ca	^{57}Co	^{125}I	^{134}Cs	^{137}Cs	Total alpha	Total beta	Total gamma
Terrestrial samples																
Milk	Near farms		4	<36 *±5.7*	72 *±6.3*	28 *±3.8*	<0.69 *±0.20*	<1.0	<2.0	<0.31	<0.050	<0.28	<0.41	-	-	-
"	"	max		<56 *±4.3*	<110 *±6.9*	34 *±3.6*	<0.75 *±0.20*			<0.33				-	-	-
"	"	sub-sets	1	-	-	-	-	-	-	<0.20	-	<0.23	<0.25	-	-	-
"	Far farms		3	10 *±1.2*	11 *±1.1*	19 *±4.1*	-	<1.0 *±0.27*	<2.0	<0.30	<0.050	<0.33	<0.42	-	-	-
"	"	max		<11 *±1.7*	<14 *±1.9*	23 *±5.1*		<1.1 *±0.5*								
Barley			1	- *±9.0*	84 *±22*	160	-	<1.0	<2.0	<0.40	<0.092	<0.5	<0.5	-	-	-
Cabbage			2	<23 *±3.5*	<59 *±5.0*	<16 *±2.8*	-	<2.2 *±0.57*	<2.0	<0.20	<0.11	<0.2	<0.4	-	-	-
"	max			36 *±5.0*	110 *±7.0*			3.4 *±0.8*			<0.15			-	-	-
Honey			1	- *±9.0*	83 *±13*	100	-	<1.0	<2.0	<0.20	<0.10	<0.3	<0.4	-	-	-
Potatoes			1	17 *±5.0*	50 *±6.0*	26 *±5.0*	-	<1.0	<2.0	<0.20	<0.20	<0.3	<0.4	-	-	-
Raspberries			1	10 *±2.0*	62 *±6.0*	37 *±5.0*	-	<1.0	<2.0	<0.20	<0.12	<0.3	<0.4	-	-	-
Spinach			1	28 *±6.0*	77 *±6.0*	26 *±4.0*	-	<1.0	<2.0	<0.30	<0.11	<0.4	<0.5	-	-	-
Turnips			1	9.0 *±4.0*	33 *±6.0*	13 *±4.0*	-	<1.0	<2.0	<0.10	<0.20	<0.5	<0.6	-	-	-
Grass			2	210 *±17*	480 *±26*	52 *±4.0*	-	<1.0	7.2 *±2.4*	<0.30	<0.20	<0.4	<0.4	-	-	-
"	max			290 *±21*	660 *±33*	67 *±4.0*										
Rape			1	64 *±6.0*	210 *±8.0*	37 *±5.0*	-	2.3 *±0.8*	11 *±1.4*	<0.20	<0.20	<0.4	<0.6	-	-	-
Silage			1	91 *±17*	130 *±7.0*	45 *±6.0*	-	-	-	-	-	-	-	-	-	-
Dry cloths			94	-	-	-	-	-	-	-	-	-	-	0.18 *±0.22*	0.64 *±0.46*	0.45 *±0.30*

\- *not analysed*
* *not detected by the method used*
[a] *except for milk and sea water where units are Bq l^{-1}, for dry cloths where units are Bq per cloth and for sediment where dry concentrations apply*
[b] *landing point or sampling area.*
[c] *Data are arithmetic means unless stated as 'max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 5 for definition.*
[d] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*
[e] *only two samples were analysed*

Table 36(b). Monitoring of radiation dose rates near Cardiff, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
East of pipeline	Mud	2	0.079
West of pipeline	"	2	0.063
Beta dose rates			µSv h^{-1}
West of pipeline	"	1	*

[a] *See section 5 for definition*
* *Not detected by the method used*

Table 37. Radioactivity in the environment near Derby, 1995

Material	No. of samples	Mean radioactivity concentration, Bq kg^{-1}			
		U	^{234}U	^{235}U	^{238}U
Grass[a]	4	0.53 *±0.08*	0.14 *±0.02*	<0.012 *±0.003*	0.12 *±0.02*
" max		0.75 *±0.10*	0.23 *±0.03*	0.016 *±0.005*	0.20 *±0.03*
Soil[b]	4	85 *±8.3*	- -	- -	- -
" max		110 ±9.3			

[a] *fresh weight*
[b] *dry weight*
- *not analysed*

Table 38. ***Radioactivity in grass and soil near nuclear sites - EURATOM[c] sampling, 1995***

Site/material	No. of samples	Selection[b]	Mean radioactivity concentration (dry)[a]							
			^{3}H	^{14}C	^{35}S	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$	^{241}Am
Grass										
Aldermaston	3		<25 *±9.8*	96 *±14*	4.2 *±1.7*	6.1 *±0.4*	<1.0	<0.010	<0.014 *±0.003*	-
		max	56 *±17*	100 *±15*	5.3 *±1.3*	6.6 *±0.4*			0.021 *±0.003*	
Amersham	3		<14 *±3.5*	100 *±13*	47 *±4.7*	6.4 *±0.6*	2.4 *±1.9*	<0.010	0.05 *±0.01*	-
		max	19 *±4.4*	130 *±16*	55 *±4.6*	9.1 *±0.7*	3.4 *±1.8*		0.066 *±0.008*	
Cardiff	3		690 *±58*	620 *±53*	4.8 *±2.1*	4.2 *±0.3*	<1.0	<0.010	<0.02 *±0.003*	-
		max	1500 *±94*	840 *±67*	9.0 *±2.0*	5.8 *±0.4*			0.026 *±0.004*	
Berkeley	3		45 *±11*	110 *±12*	19 *±2.3*	2.3 *±0.3*	<1.0	<0.010	<0.010	-
		max	82 *±17*	130 *±13*	23 *±2.3*	4.0 *±0.4*				
Bradwell	3		<19 *±8.5*	110 *±15*	12 *±2.0*	<1.9 *±0.23*	<1.5 *±1.5*	<0.010	<0.010	-
		max	29 *±14*	110 *±16*	18 *±2.5*	3.9 *±0.3*	2.6 *±2.6*			
Capenhurst	3		-	110 *±13*	<7.5 *±1.2*	3.9 *±0.3*	<2.0 *±2.0*	<0.010	<0.010	-
		max		110 *±12*	18 *±1.7*	4.3 *±0.3*	3.1 *±2.6*			
Dungeness	2		<20	180 *±19*	14 *±1.9*	4.8 *±0.4*	7.6 *±2.7*	<0.010 *±0.002*	<0.049 *±0.004*	-
		max	30 *±14*	240 *±24*	22 *±2.1*	8.6 *±0.5*	11 *±2.9*	0.010 *±0.002*	0.089 *±0.006*	
Hartlepool	3		52 *±11*	100 *±14*	<1.8 *±1.5*	1.5 *±0.3*	<1.0	<0.010	<0.010	-
		max	83 *±17*	100 *±12*	2.6 *±1.7*	2.6 *±0.2*				
Harwell	3		70 *±14*	93 *±12*	<7.0 *±1.1*	2.0 *±0.5*	<1.0	<0.010	<0.014 *±0.003*	<0.010
		max	87 *±7.2*	100 *±15*	19 *±1.9*	2.3 *±0.7*			0.020 *±0.004*	
Heysham	3		44 *±14*	150 *±17*	<3.1 *±2.3*	3.4 *±0.3*	<1.7 *±1.6*	<0.010	0.014 *±0.002*	-
		max	68 *±17*	180 *±18*	5.3 *±3.5*	4.1 *±0.3*	2.4 *±1.9*		0.020 *±0.003*	
Hinkley Point	3		56 *±11*	140 *±13*	31 *±2.9*	4.0 *±0.5*	<1.0	<0.010	<0.010	-
		max	61 *±6.5*	190 *±16*	57 *±4.0*	5.9 *±0.5*				
Oldbury	3		46 *±13*	170 *±18*	200 *±15*	<2.0 *±0.3*	<1.0	<0.010	<0.010	-
		max	53 *±16*	250 *±25*	450 *±24*	2.9 *±0.4*				
Sellafield	3		-	220 *±22*	24 *±7.5*	45 *±2.4*	11 *±3.6*	0.10 *±0.01*	0.75 *±0.05*	0.43 *±0.04*
		max		270 *±25*	55 *±12*	52 *±2.8*	13 *±3.1*	0.15 *±0.02*	1.1 *±0.1*	0.55 *±0.05*
Sizewell	3		21 *±9.3*	120 *±16*	39 *±2.9*	4.1 *±0.31*	<2.8 *±1.8*	<0.010	<0.010	<0.010
		max	40 *±15*	130 *±17*	59 *±3.7*	4.5 *±0.3*	6.4 *±3.1*			
Springfields	3		13 *±7.3*	110 *±15*	<2.0 *±1.0*	4.8 *±0.33*	<1.7 *±1.5*	<0.010	<0.032 *±0.004*	-
		max	17 *±8.6*	130 *±17*	4.1 *±1.7*	7.2 *±0.4*	2.9 *±1.8*		0.051 *±0.006*	
Trawsfynydd	3		-	120 *±15*	<2.3 *±0.6*	8.7 *±0.5*	39 *±5.5*	<0.010	<0.012 *±0.002*	-
		max		130 *±14*	4.9 *±1.1*	10 *±0.6*	78 *±7.5*		0.017 *±0.003*	
Winfrith	3		96 *±18*	109 *±15*	3.1 *±1.6*	6.3 *±0.5*	7.6 *±3.5*	<0.010	<0.017 *±0.003*	-
		max	170 *±26*	120 *±16*	4.6 *±1.3*	9.2 *±0.6*	15 *±5.1*		0.031 *±0.005*	
Wylfa	3		-	120 *±15*	20 *±1.9*	6.8 *±0.5*	<2.9 *±2.2*	<0.010	<0.010 *±0.001*	-
		max		140 *±17*	36 *±2.6*	9.5 *±0.7*	5.4 *±3.3*		0.011 *±0.002*	

Table 38. continued

Site/material	No. of samples	Selection[b]	Mean radioactivity concentration (dry)[a]							
			^{3}H	^{14}C	^{35}S	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$	^{241}Am
Soil										
Aldermaston	3		-	7.9 *±2.7*	<1.0	4.7 *±0.5*	13 *±2.1*	<0.011 *±0.004*	0.20 *±0.02*	-
		max		10 *±2.5*		6.9 *±0.5*	18 *±2.2*	0.011 *±0.005*	0.24 *±0.02*	
Amersham	3		-	18 *±2.6*	2.3 *±1.5*	5.1 *±0.4*	12 *±1.9*	0.019 *±0.007*	0.26 *±0.03*	-
		max		22 *±2.8*	2.9 *±1.1*	10 *±0.7*	13 *±2.2*	0.031 *±0.009*	0.28 *±0.03*	
Cardiff	3		-	73 *±6.1*	<1.0	4.4 *±0.4*	21 *±2.6*	<0.021 *±0.006*	0.40 *±0.03*	-
		max		130 *±8.9*		8.6 *±0.5*	28 *±2.8*	0.034 *±0.008*	0.56 *±0.04*	
Berkeley	3		-	24 *±3.5*	<2.3 *±1.1*	6.3 *±0.5*	23 *±2.6*	0.029 *±0.005*	0.66 *±0.04*	-
		max		43 *±4.6*	5.0 *±1.9*	7.9 *±0.5*	36 *±3.2*	0.052 *±0.007*	1.2 *±0.1*	
Bradwell	3		-	12 *±2.4*	<1.0	5.4 *±0.5*	12 *±2.0*	<0.011 *±0.004*	0.12 *±0.02*	-
		max		25 *±3.0*		10 *±0.7*	29 *±2.7*	0.013 *±0.007*	0.22 *±0.03*	
Capenhurst	3		-	16 *±3.4*	<1.1 *0.52*	2.5 *±0.4*	19 *±2.7*	<0.014 *±0.005*	0.37 *±0.03*	-
		max		21 *±3.8*	1.3 *±0.9*	3.2 *±0.4*	30 *±3.0*	0.018 *±0.007*	0.55 *±0.04*	
Dungeness	2		-	98 *±13*	<1.0	26 *±1.5*	180 *±13*	0.15 *±0.02*	3.5 *±0.2*	-
		max		130 *±14*		35 *±1.9*	210 *±14*	0.16 *±0.02*	3.8 *±0.2*	
Hartlepool	3		-	17 *±3.0*	<1.0	<3.4 *±0.3*	17 *±2.2*	0.021 *±0.007*	0.34 *±0.03*	-
		max		19 *±3.1*		5.9 *±0.4*	21 *±2.5*	0.031 *±0.008*	0.50 *±0.04*	
Harwell	3		-	16 *±3.4*	<3.6 *±3.9*	<7.5 *±0.6*	26 *±2.8*	0.11 *±0.02*	1.3 *±0.1*	0.35 *±0.04*
		max		28 *±4.0*	8.1 *±5.5*	13 *±0.9*	44 *±3.6*	0.223 *±0.033*	1.9 *±0.1*	0.53 *±0.05*
Heysham	3		-	16 *±3.0*	<1.0	3.6 *±0.4*	32 *±3.4*	0.035 *±0.008*	0.40 *±0.03*	-
		max		23 *±3.5*		7.0 *±0.5*	53 *±4.5*	0.061 *±0.001*	0.58 *±0.04*	
Hinkley Point	3		-	18 *±3.2*	10 *±3.2*	8.9 *±0.8*	11 *±2.3*	<0.016 *±0.003*	0.24 *±0.20*	-
		max		39 *±4.4*	18 *±4.4*	21 *±1.3*	21 *±3.5*	0.029 *±0.006*	0.41 *±0.03*	
Oldbury	3		-	25 *±3.6*	<2.8 *±1.1*	4.1 *±0.4*	32 *±3.6*	0.044 *±0.009*	0.51 *±0.04*	-
		max		34 *±4.2*	6.5 *±1.9*	5.2 *±0.4*	39 *±3.5*	0.095 *±0.012*	0.54 *±0.04*	
Sellafield	3		-	21 *±3.6*	<2.5 *±1.2*	24 *±2.0*	150 *±11*	0.84 *±0.12*	16 *±1.1*	4.7 *±0.6*
		max		40 *±4.5*	4.9 *±1.5*	39 *±2.2*	300 *±18*	1.6 *±0.2*	31 *±1.8*	10 *±1.0*
Sizewell	3		-	9.1 *±3.4*	<1.0	2.1 *±0.4*	10 *±1.5*	<0.011 *±0.003*	0.13 *±0.02*	0.041 *±0.012*
		max		16 *±5.0*		2.5 *±0.2*	16 *±2.0*	0.012 *±0.005*	0.23 *±0.02*	0.067 *±0.011*
Springfields	3		-	12 *±2.6*	<1.0	3.3 *±0.3*	17 *±2.2*	0.022 *±0.006*	0.30 *±0.02*	-
		max		14 *±2.8*		5.3 *±0.4*	21 *±2.3*	0.035 *±0.007*	0.35 *±0.03*	
Trawsfynydd	3		-	48 *±6.7*	<2.8 *±1.8*	11 *±0.9*	180 *±14*	0.092 *±0.013*	2.7 *±0.1*	-
		max		67 *±9.4*	3.8 *±2.6*	24 *±1.4*	260 *±18*	0.14 *±0.02*	4.5 *±0.2*	
Winfrith	3		-	13 *±2.7*	<1.2 *±0.9*	5.5 *±0.5*	24 *±2.8*	0.019 *±0.008*	0.49 *±0.04*	-
		max		16 *±3.2*	1.4 *±1.0*	8.6 *±0.7*	38 *±3.8*	0.026 *±0.011*	0.66 *±0.05*	
Wylfa	3		-	9.4 *±2.5*	5.4 *±1.9*	2.9 *±0.4*	32 *±3.0*	<0.019 *±0.005*	0.30 *±0.03*	-
		max		11 *±2.8*	11 *±1.3*	4.3 *±0.5*	33 *±3.1*	0.027 *±0.004*	0.32 *±0.03*	

\- *not analysed*
[a] *Except for ^{3}H where wet concentrations apply*
[b] *Data are arithmetic means unless stated as 'max' in this column*
'Max ' data are selected to be maxima. If no 'max' value is given,the mean is also the maximum
[c] *Other data for grass and soil samples near nuclear sites can be found in the site-specific tables*

Table 39. Comparison of highest observed grass and soil concentrations with Generalised Derived Limits[b], 1995

	Mean activity concentration Bq kg^{-1} (dry)							
	Grass				Soil			
	Observed	GDL	%	Site	Observed	GDL[a]	%	Site
^{3}H	690	30000	2	Cardiff	-			
^{14}C	620	4000	16	Cardiff	-			
^{35}S	200	20000	1	Oldbury	10	30000	<1	Hinkley
^{90}Sr	45	2000	2	Sellafield	26	400	7	Dungeness
^{137}Cs	39	3000	1	Trawsfynydd	180	1000	18	Dungeness
^{238}Pu		-			0.84	5000	<1	Sellafield
$^{239+240}Pu$		-			16	5000	<1	Sellafield
^{241}Am		-			4.7	5000	<1	Sellafield

\- *not available*
[a] *Assumed to be well mixed soil, 0-30 cm*
[b] *Based on Attwood et al, 1996 and MAFF assessments*

Table 40. Natural radioactivity in fish and shellfish from the Irish Sea, 1995

Material	Location[a]	No. of sampling observ-ations	Mean radioactivity concentration (wet), Bq kg^{-1}								
			^{210}Po	^{210}Pb	^{226}Ra	^{228}Th	^{230}Th	^{232}Th	^{234}U	^{235}U	^{238}U
Winkles	Saltom Bay	4	15 *±0.6*	2.6 *±0.2*	-	-	-	-	-	-	-
"	Parton	4	21 *±0.9*	4.6 *±0.3*	1.8 *±0.1*	0.66 *±0.05*	1.8 *±0.1*	0.45 *±0.03*	1.4 *±0.1*	0.045 *±0.02*	1.3 *±0.1*
"	North Harrington	4	18 *±0.7*	-	-	-	-	-	-	-	-
"	Fleswick Bay	4	14 *±0.7*	-	-	-	-	-	-	-	-
"	Nethertown	4	11 *±0.5*	-	-	-	-	-	-	-	-
"	Drigg	4	-	-	-	1.1 *±0.1*	1.5 *±0.1*	0.8 *±0.1*	-	-	-
"	Tarn Bay	4	10 *±0.4*	-	-	-	-	-	-	-	-
Mussels	Parton	2	50 *±2.0*	-	-	-	-	-	-	-	-
"	Nethertown	4	32 *±1.0*	2.7 *±0.2*	-	-	-	-	-	-	-
Limpets	St Bees	4	12 *±0.6*	1.8 *±0.2*	-	-	-	-	-	-	-
Crabs	Parton	4	22 *±1.1*	0.17 *±0.03*	-	0.095 *±0.005*	0.025 *±0.002*	0.010 *±0.001*	0.054 *±0.004*	0.0021 *±0.0006*	0.051 *±0.004*
"	St Bees	4	13 *±0.9*	0.67 *±0.07*	-	-	-	-	-	-	-
"	Sellafield coastal area	4	11 *±0.6*	0.19 *±0.03*	-	-	-	-	-	-	-
Lobsters	Parton	4	13 *±0.9*	0.07 *±0.01*	-	0.044 *±0.003*	0.016 *±0.001*	0.0062 *±0.0008*	0.024 *±0.002*	0.0008 *±0.0004*	0.023 *±0.002*
"	St Bees	4	10 *±0.4*	0.002 *±0.0002*	-	-	-	-	-	-	-
Cod	Parton	4	0.64 *±0.04*	0.011 *±0.002*	-	0.022 *±0.001*	0.0036 *±0.0002*	0.0015 *±0.0002*	0.0048 *±0.0004*	0.00015 *±0.00008*	0.0046 *±0.0004*
Flounder	Whitehaven	1	4.3 *±0.1*	-	-	-	-	-	-	-	-

\- *not analysed*
[a] *landing point or sampling area*

Table 41. Radioactivity in food and the environment near industrial sites, 1995

Site	Material	No. of samples	Mean radioactivity concentration (dry)[a], Bq kg^{-1}							
			^{134}Cs	^{137}Cs	^{210}Pb	^{210}Po	^{226}Ra	^{232}Th	^{238}Pu	$^{239+240}$Pu
Eggborough, North Yorkshire	Grass	4	<0.80	<0.76 *±0.42*	17 *±3.3*	11 *±3.1*	1.7 *±0.3*	0.81 *±0.07*	<0.00040	<0.00041 *±0.0001*
	Soil	4	<0.60	16 *±2.0*	31 *±3.1*	30 *±1.4*	25 *±4.2*	24 *±2.2*	0.0092 *±0.0032*	0.28 *±0.02*
	Rabbit	1	<0.20	0.30 *±0.1*	0.15 *±0.03*	0.10 *±0.01*	0.060 *±0.02*	<0.0050	<0.00030	0.00040 *±0.0002*
Ellesmere, Cheshire	Grass	3	<0.70	1.1 *±0.6*	15 *±1.7*	7.5 *±0.5*	1.1 *±0.2*	0.67 *±0.05*	<0.00039	<0.00040
	Soil	3	<0.40	12 *±1.4*	22 *±2.3*	22 *±0.9*	13 *±2.1*	11 *±0.8*	0.0070 *±0.003*	0.18 *±0.01*
Milford Haven, Dyfed	Grass	3	<0.90	<0.79 *±0.35*	21 *±2.2*	7.8 *±0.6*	0.91 *±0.15*	0.55 *±0.08*	<0.00056	<0.00044 *±0.00018*
	Soil	3	<0.60	8.6 *±1.0*	33 *±3.5*	33 *±1.5*	24 *±3.9*	27 *±1.7*	0.0095 *±0.0033*	0.20 *±0.015*
	Sheep	2	<0.25	<0.25	<0.007	0.005 *±0.001*	0.013 *±0.003*	0.002 *±0.001*	<0.00025	<0.00021 *±0.00005*
Marloes, Dyfed [b]	Grass	1	<0.80	<0.80	19 *±1.0*	8.1 *±0.5*	1.3 *±0.2*	0.41 *±0.05*	<0.00050	0.00070 *±0.0002*

- not analysed
[a] *except for animal samples where wet concentrations apply*
[b] *control for Milford Haven*

Table 42. Radioactivity in plants near landfill sites, 1995

Sampling location	Material	No. of samples	Mean radioactivity concentration (dry)[a], Bq kg^{-1}							
			^{3}H	^{14}C	^{90}Sr	^{125}I	^{134}Cs	^{137}Cs	^{238}Pu	$^{239+240}$Pu
Clifton Marsh, Lancashire	Grass	4	61 *±15*	110 *±20*	2.5 *±0.1*	<1.0	<0.80	<2.1 *±0.5*	<0.00028	<0.00040 *±0.00022*
Cowpen Bewley, Cleveland	"	4	41 *±10*	110 *±20*	0.57 *±0.05*	<0.68	<0.90	<0.83	<0.00020	<0.00025
Cilgwyn Quarry, Gwynedd	Nettles	3	99 *±24*	130 *±23*	13 *±0.4*	<2.2	<0.90	1.7 *±0.6*	<0.00070	<0.00060 *±0.00027*
Milton Landfill, Cambridgeshire	Grass	4	84 *±22*	130 *±19*	0.86 *±0.05*	<0.70	<1.0	<0.88 *±0.25*	<0.00020	<0.00045

[a] *Results are available for other artificial nuclides detectable by gamma spectrometry*
All such results are less than the limit of detection

Table 43. Caesium radioactivity in the freshwater environment, 1995

Location	Material	No. of sampling observa-tions	Mean radioactivity concentration (wet)[a], Bq kg^{-1}	
			^{134}Cs	^{137}Cs
England				
Branthwaite	Rainbow trout	1	*	0.42 *±0.13*
Narborough	"	1	*	0.16 *±0.08*
Ennerdale Water	Water	1	*	0.0046 *±0.0008*
Devoke Water	Perch	1	6.8 *±1.0*	310 *±5.3*
"	Brown trout	1	2.2 *±0.6*	74 *±1.7*
"	Water	1	*	0.024 *±0.009*
Wales				
Llyn Hiraethlyn	Perch	1	3.1 *±0.5*	110 *±1.9*
"	Water	1	*	0.013 *±0.001*
Scotland				
Loch Dee	Brown trout	1	4.8 *±0.5*	180 *±2.9*
"	Water	3	*	0.027 *±0.0009*

* *not detected by the method used*
[a] *except for water where units are Bq l^{-1}*

Table 44. Radioactivity in terrestrial food from the Isle of Man, 1995

Material or selection[c]	No. of sampling observations[b]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}														
		^{3}H	^{14}C	^{35}S	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{129}I	Total Cs	^{147}Pm	^{144}Ce	^{238}Pu	$^{239+240}Pu$	^{241}Pu	^{241}Am
Milk[d]	4	<10	<15 *±3.1*	<1.0	<0.48	<0.19	<0.040	<2.6	<0.018	<0.20 *±0.01*	<0.38	<0.20	<0.00020	<0.00020	<0.10	<0.00023
" max			17 *±3.8*		<0.53	<0.20		<2.9	<0.020	<0.21 *±0.01*	<0.60	<2.2				<0.00030
" subsets	3	-	-	-	<0.30	0.058 *±0.010*	-	<1.9	-	<0.30[e]	-	<1.2	-	-	-	-
" max						0.068 *±0.010*		<2.0				<1.4				
Apples	1	<10	14 *±5.0*	<1.0	<0.40	<0.20	-	<2.8	-	<0.20	-	<1.4	-	-	-	-
Cabbage	1	<10	<15	<1.0	<0.60	1.3 *±0.1*	<0.040	<3.1	<0.050	0.35 *±0.07*	<0.00030	<2.6	<0.00020	<0.00020	<0.10	0.0003 *±0.00030*
" subsets	1	-	-	-	<0.50	-	-	<1.7	-	0.6[e] *±0.1*	-	<1.7	-	-	-	-
Honey	1	<10	50 *±17*	<1.0	<0.60	<0.20	-	<3.8	-	3.7 *±0.2*	-	<2.2	-	-	-	-
Ovine muscle	1	<10	31 *±6.0*	<3.0	<0.40	<0.20	<0.040	<3.9	<0.070	2.9 *±0.2*	-	<1.8	<0.00030	<0.00030	<0.10	<0.00030
Ovine offal	1	<10	33 *±8.0*	<3.0	<0.3	0.34 *±0.04*	<0.040	<2.8	<0.050	1.4 *±0.1*	-	<1.7	<0.00020	<0.00020	<0.10	0.00050 *±0.00040*
Potatoes	1	<10	16 *±3.0*	<1.0	<0.20	<0.20	<0.040	<1.7	<0.040	<0.20	<0.30	<1.2	<0.00020	0.00080 *±0.00040*	<0.10	0.00040 *±0.00020*
Runner beans	1	<10	<15	<1.0	<0.50	<0.20	-	<2.8	-	<0.20	-	<2.1	-	-	-	-

- *not analysed*
* *not detected by the method used*
[a] *except for milk where units are Bq l^{-1}*
[b] *See section 5 for definition*
[c] *Data are arithmetic means unless stated as 'max in this column. 'Max' data are selected to be maxima If no 'max' value is given, the mean is also the maximum. See section 5 for definition*
[d] *The concentration of ^{3}H (organic) was <10 Bq l^{-1}*
[e] *Caesium-137*

Table 45. ***Radioactivity in seafood and the environment near the Channel Islands, 1995***

Material	Location[b]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																
			^{3}H	^{14}C	^{54}Mn	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{110m}Ag	^{125}Sb	^{129}I	^{137}Cs	^{155}Eu	^{238}Pu	^{239}Pu + ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total beta
Crabs	Guernsey	1	-	-	*	0.31 *±0.07*	-	-	*	*	*	-	*	*	0.00082 *±0.00007*	0.0031 *±0.0002*	0.0065 *±0.0003*	0.000047 *±0.000041*	0.00066 *±0.00007*	95
"	Jersey	1	-	-	*	0.26 *±0.03*	-	-	*	*	*	-	*	*	0.00038 *±0.00005*	0.00082 *±0.00007*	0.0027 *±0.0001*	0.000025 *±0.000018*	0.00070 *±0.00006*	79
"	Alderney	2	-	26 *±9.4*	*	0.44 *±0.10*	-	0.16 *±0.06*	*	*	*	-	0.07 *±0.06*	*	0.00088 *±0.00006*	0.0022 *±0.0001*	0.0050 *±0.0002*	0.000058 *±0.000027*	0.0013 *±0.0001*	69
Lobsters	Guernsey	1	-	-	*	0.18 *±0.12*	-	-	*	*	*	-	*	*	0.00063 *±0.00007*	0.0017 *±0.0001*	0.010 *±0.0004*	0.00019 *±0.00009*	0.0024 *±0.0001*	49
"	Jersey	1	-	-	*	0.21 *±0.11*	-	-	*	*	*	-	0.13 *±0.08*	*	0.00024 *±0.00004*	0.00066 *±0.00007*	0.0016 *±0.0001*	*	0.00021 *±0.00004*	100
"	Alderney	1	-	-	*	0.11 *±0.09*	-	-	*	*	*	-	*	*	0.0017 *±0.0001*	0.0077 *±0.0003*	0.029 *±0.001*	0.00017 *±0.00006*	0.0046 *±0.0002*	63
Winkles	Alderney	1	-	-	*	3.1 *±0.3*	0.22 *±0.02*	-	*	*	*	-	0.18 *±0.16*	*	0.014 *±0.001*	0.029 *±0.001*	0.055 *±0.003*	0.00025 *±0.00022*	0.012 *±0.001*	40
Oysters	Jersey	1	-	-	*	0.33 *±0.07*	-	-	*	0.19 *±0.10*	*	-	*	*	0.0052 *±0.0002*	0.011 *±0.0004*	0.013 *±0.001*	0.000073 *±0.000045*	0.0028 *±0.0002*	70
Limpets	Guernsey	1	-	-	*	*	-	-	*	*	*	-	*	*	-	-	*	-	-	48
"	Jersey La Rozel	1	-	-	*	0.24 *±0.07*	-	-	*	*	*	-	*	*	0.0056 *±0.0003*	0.012 *±0.0004*	0.018 *±0.001*	0.00013 *±0.00008*	0.0034 *±0.0002*	58
"	Alderney	1	-	-	*	0.49 *±0.08*	-	-	0.54 *±0.47*	*	*	-	*	*	0.0093 *±0.0003*	0.016 *±0.001*	0.033 *±0.002*	0.00018 *±0.00013*	0.0075 *±0.0007*	71
Ormers	Guernsey	1	-	-	*	0.14 *±0.08*	-	-	*	*	*	-	*	*	-	-	*	-	-	89
Porphyra	Guernsey Fermain Bay	4	-	-	*	*	-	-	0.10 *±0.13*	*	*	-	0.01 *±0.01*	*	0.0012 *±0.0001*	0.0035 *±0.0002*	0.0052 *±0.0003*	0.000027 *±0.000026*	0.00083 *±0.00010*	110
"	Jersey Plemont Bay	4	-	-	*	0.16 *±0.08*	-	-	0.25 *±0.16*	*	*	-	0.07 *±0.04*	*	-	-	*	-	-	340
"	Alderney Quenard Point	4	-	-	*	0.15 *±0.06*	-	-	0.69 *±0.39*	*	*	-	0.02 *±0.03*	*	-	-	*	-	-	120

Table 45. continued

Material	Location[b]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																	
			^{3}H	^{14}C	^{54}Mn	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{110m}Ag	^{125}Sb	^{129}I	^{137}Cs	^{155}Eu	^{238}Pu	^{239}Pu + ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total beta
Fucus vesiculosus	Alderney Quenard Point	3	-	-	*	0.62 *±0.05*	0.17 *±0.01*	-	*	*	*	1.3 *±0.5*	0.09 *±0.03*	*	0.0087 *±0.0003*	0.018 *±0.0004*	0.010 *±0.0004*	0.000056 *±0.000037*	0.0030 *±0.0002*	120
Fucus serratus	Guernsey Fermain Bay	4	-	-	*	0.66 *±0.18*	0.11 *±0.01*	-	*	*	*	-	0.04 *±0.02*	*	0.012	0.032	0.012	0.000058	0.0027	170
"	Jersey La Rozel	4	-	-	*	1.0 *±0.1*	0.15 *±0.01*	-	*	*	*	-	0.15 *±0.07*	0.03 *±0.04*	0.025 *±0.001*	0.050 *±0.002*	0.023 *±0.001*	0.00023 *±0.00010*	0.0050 *±0.0003*	270
"	Alderney Quenard Point	2	-	-	*	0.92 *±0.09*	-	-	*	*	*	-	0.12 *±0.06*	0.12 *±0.09*	-	-	*	-	-	110
Laminaria digitata	Jersey Verclut	3	-	-	*	0.09 *±0.05*	-	-	*	*	*	-	0.17 *±0.05*	*	-	-	*	-	-	370
Mud	Jersey St Helier	1	-	-	0.77 *±0.47*	26 *±0.8*	-	-	*	*	*	-	6.1 *±0.4*	1.7 *±1.1*	1.2 *±0.1*	2.6 *±0.1*	4.4 *±0.1*	0.018 *±0.011*	0.81 *±0.05*	570
Mud & sand	Guernsey Bordeaux Harbour	1	-	-	*	0.52 *±0.38*	-	-	*	*	*	-	1.9 *±0.3*	*	0.087 *±0.006*	0.31 *±0.01*	0.28 *±0.01*	*	0.043 *±0.004*	450
Sand	Alderney Lt. Crabbe Harbour	1	-	-	*	1.6 *±0.2*	-	-	*	*	0.49 *±0.35*	-	2.2 *±0.2*	0.56 *±0.36*	-	-	*	-	-	370
Sea water	Guernsey	4	-	-	-	-	-	-	-	-	-	-	0.005 *±0.001*	-	-	-	-	-	-	-
"	Jersey	1	-	-	-	-	-	-	-	-	-	-	0.005 *±0.0004*	-	-	-	-	-	-	-
"	Alderney	3	*	-	-	-	-	-	-	-	-	-	0.007 *±0.001*	-	-	-	-	-	-	-

\- *not analysed*
* *not detected by the method used*
[a] *Except for seawater where units are Bq l^{-1} and for sediment where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *See section 5 for definition*

Table 46. Radioactivity in regional diet, 1995

Region	Mean radioactivity concentration (dry)[a], Bq kg^{-1}												
	^{3}H	^{14}C	^{35}S	^{40}K	^{90}Sr	^{137}Cs	^{210}Pb	^{210}Po	^{226}Ra	U	^{238}Pu	$^{239+240}$Pu	^{241}Am
Wales	14 *±1.0*	43 *±5.0*	<1.0	70 *±8.0*	<0.40	0.20 *±0.10*	0.02 *±0.01*	0.036 *±0.004*	0.043 *±0.007*	0.023 *±0.005*	<0.0001	<0.0001	<0.0002
East Midlands	9.3 *±5.0*	35 *±4.0*	<1.0	72 *±8.0*	0.26 *±0.07*	<0.20	0.20 *±0.10*	0.022 *±0.009*	0.08 *±0.01*	0.022 *±0.005*	<0.0002	<0.0002	<0.0002
South West	17 *±5.0*	37 *±5.0*	<1.0	72 *±8.0*	<0.50	<0.1	0.013 *±0.008*	0.036 *±0.004*	0.045 *±0.007*	0.019 *±0.005*	<0.0002	<0.0002	<0.0001
North East	5.0 *±3.0*	44 *±7.0*	<1.0	76 *±9.0*	<0.40	0.30 *±0.10*	0.021 *±0.007*	0.039 *±0.004*	0.047 *±0.007*	0.017 *±0.005*	<0.0001	<0.0001	<0.0003
South East	11 *±6.0*	61 *±6.0*	<1.0	75 *±9.0*	0.11 *±0.05*	<0.20	0.05 *±0.02*	0.036 *±0.006*	0.039 *±0.009*	0.020 *±0.006*	<0.0001	<0.0002	<0.0009
West Midlands	7.0 *±5.0*	39 *±4.0*	<1.0	78 *±9.0*	0.20 *±0.10*	<0.20	0.03 *±0.01*	0.046 *±0.005*	0.034 *±0.007*	0.017 *±0.005*	<0.0001	<0.0001	<0.0001
East	82 *±10*	46 *±4.0*	<1.0	79 *±9.0*	0.10 *±0.10*	<0.10	0.037 *±0.007*	0.039 *±0.003*	0.035 *±0.008*	0.015 *±0.005*	<0.0001	<0.0002	<0.0002
South	4.5 *±4.0*	42 *±5.0*	<1.0	80 *±9.0*	<0.70	<0.20	0.05 *±0.01*	0.035 *±0.009*	0.042 *±0.006*	0.023 *±0.005*	<0.0001	<0.0002	<0.0003
North West	12 *±10*	42 *±4.0*	<1.0	79 *±9.0*	0.10 *±0.08*	<0.20	0.033 *±0.007*	0.06 *±0.03*	0.037 *±0.008*	0.020 *±0.005*	<0.0001	<0.0002	<0.0002

[a] *Results are available for other artificial nuclides detectable by gamma spectrometry (^{60}Co, ^{95}Zr, ^{103}Ru, ^{110m}Ag, ^{134}Cs, ^{144}Ce) All such results are less than the limit of detection*

Table 47. Estimates of radiation exposure from radionuclides in regional diet, 1995

	Exposure, mSv[b]	
Nuclide[a]	Mean	Range
Man-made radionuclides		
Tritium	0.0002	0.00004-0.0008
Sulphur-35	0.001	0.001-0.001
Strontium-90	0.006	0.002-0.014
Caesium-137	0.0004	0.0002-0.0007
Plutonium-238	0.000009	0.000008-0.00002
Plutonium-239+240	0.00001	0.000008-0.00002
Americium-241	0.00002	0.000007-0.00007
Sub-total	0.008	0.004-0.016
Natural radionuclides		
Carbon-14	0.013	0.011-0.019
Lead-210	0.035	0.009-0.14
Polonium-210	0.066	0.038-0.10
Radium-226	0.008	0.006-0.015
Uranium	0.0005	0.0004-0.0006
Sub-total	0.12	0.091-0.20
Total	0.13	0.10-0.21

[a] *Tritium is also produced by natural means and carbon-14 by man. Levels of natural radionuclides may be enhanced by man's activities*

[b] *To a 1 year old child consuming at average rates*

Table 48. Radioactivity in milk remote from nuclear sites, 1995

County	Selection[a]	No. of sampling observa-tions[b]	Mean radioactivity concentration, Bq l^{-1}								
			^{3}H	^{14}C	^{90}Sr	Total Cs	^{210}Pb	^{210}Po	Total U	^{238}Pu	$^{239}Pu+^{240}Pu$
Co. Antrim		12	<10	<17 *±3.3*	<0.10	0.37 *±0.03*	0.038 *±0.016*	0.011 *±0.005*	<0.0064	<0.00020	<0.00020
	max			28 *±4.0*		0.51 *±0.04*					
Co. Armagh		12	<10	17 *±3.7*	<0.10	<0.20	0.056 *±0.018*	<0.010	<0.0064	<0.00020	<0.00020
	max			23 *±5.0*							
Cambridgeshire		12	<2.0	16 *±3.6*	0.029 *±0.006*	0.047 *±0.012*	0.081 *±0.029*	0.015 *±0.007*	<0.0064	<0.00020	<0.00020
	max			22 *±4.0*	0.043 *±0.007*	0.061 *±0.015*					
Denbighshire		12	<10	<17 *±3.2*	<0.10	<0.20	0.048 *±0.039*	0.016 *±0.004*	<0.0064	<0.00020	<0.00020
	max			*26* *±3.0*							
Cornwall		23	<10	18 *±3.4*	<0.10	<0.20	<0.023 *±0.018*	0.019 *±0.006*	<0.0064	<0.00020	<0.00020
	max			27 *±4.0*			0.025 *±0.025*	0.021 *±0.006*			
Co. Down		12	<10	<16 *±3.2*	<0.10	<0.20	<0.019	<0.010	<0.0064	<0.00020	<0.00020
	max			20 *±4.0*							
Co. Fermanagh		12	<10	<16 *±3.0*	<0.10	<0.25 *±0.03*	0.036 *±0.017*	<0.010	<0.0064	<0.00020	<0.00020
	max			21 *±3.0*		0.39 *±0.03*					
Gloucestershire		12	<10	<18 *±3.4*	<0.10	<0.20	0.072 *±0.028*	<0.010	<0.0064	<0.00020	<0.00020
	max			29 *±5.0*							
Gwent		8	<2.1 *±1.0*	<20 *±3.4*	0.043 *±0.006*	0.083 *±0.013*	<0.021	0.014 *±0.005*	0.0065 *±0.0025*	<0.00020	<0.00020
	max		3.0 *±2.0*	27 *±4.0*	0.057 *±0.006*	0.23 *±0.02*					
Gwynedd		12	<10	<17 *±3.3*	<0.10	<0.20	<0.025	0.013 *±0.005*	<0.0064	<0.00020	<0.00020
	max			22 *±3.0*							
Hampshire		12	<10	<15 *±3.3*	<0.10	<0.20	0.025 *±0.025*	0.018 *±0.005*	<0.0064	<0.00020	<0.00020
	max			21 *±4.0*							
Humberside		12	<10	<15 *±3.2*	<0.10	<0.20	0.055 *±0.036*	<0.010	<0.0064	<0.00020	<0.00020
	max			*22* *±4.0*							
Kent		12	<10	16 *±3.5*	<0.10	<0.20	<0.025	0.017 *±0.005*	<0.0064	<0.00020	<0.00020
	max			20 *±4.0*							

Table 48. continued

County	Selection[a]	No. of sampling observa-tions[b]	Mean radioactivity concentration, Bq l^{-1}								
			^{3}H	^{14}C	^{90}Sr	Total Cs	^{210}Pb	^{210}Po	Total U	^{238}Pu	$^{239}Pu+^{240}Pu$
Lancashire		12	<10	<18 *±3.5*	<0.10	<0.20 *±0.01*	<0.026	0.013 *±0.007*	<0.0064	<0.00020	<0.00020
	max			22 *±4.0*		0.24 *±0.03*					
Lincolnshire		12	<10	<16 *±3.4*	<0.10	<0.20	0.068 *±0.039*	0.015 *±0.004*	<0.0064	<0.00020	<0.00020
	max			23 *±4.0*							
Co. Londonderry		11	<10	18 *±3.7*	<0.10	<0.22 *±0.02*	0.055 *±0.023*	<0.010	<0.0064	<0.00020	<0.00020
	max			24 *±4.0*		0.35 *±0.03*					
Norfolk		12	<10	<16 *±2.6*	<0.10	<0.20	0.031 *±0.031*	0.016 *±0.004*	<0.0064	<0.00020	<0.00020
	max			21 *±5.0*							
North Yorkshire		12	<10	<16 *±3.0*	<0.10	<0.20	0.040 *±0.039*	0.011 *±0.004*	<0.0064	<0.00020	<0.00020
	max			*22* *±3.0*							
Oxfordshire			<10	<15 *±3.4*	<0.10	<0.20	0.022 *±0.022*	<0.010	<0.0064	<0.00020	<0.00020
	max			22 *±4.0*							
Shropshire		12	<10	<16 *±3.1*	<0.10	<0.20	<0.021	0.012 *±0.004*	<0.0064	<0.00020	<0.00020
	max			19 *±3.0*							
Somerset		12	<10	<17 *±3.5*	<0.10	<0.20	<0.025	0.019 *±0.005*	<0.0064	<0.00020	<0.00020
	max			26 *±6.0*							
Suffolk		12	<10	19 *±3.9*	<0.10	<0.20	0.029 *±0.029*	0.018 *±0.004*	<0.0064	<0.00020	<0.00020
	max			*27* *±4.0*							
Tyneside		12	<10	<15 *±2.8*	<0.10	<0.20	<0.026	0.015 *±0.004*	<0.0064	<0.00020	<0.00020
	max			18 *±3.0*							
Co. Tyrone		12	<2.0	18 *±3.8*	0.036 *±0.006*	0.17 *±0.01*	0.047 *±0.020*	<0.010	<0.0064	<0.00020	<0.00020
	max			27 *±5.0*	0.049 *±0.006*	0.22 *±0.02*					
West Midlands		12	<10	<16 *±3.3*	<0.10	<0.20	<0.025	0.014 *±0.004*	<0.0064	<0.00020	<0.00020
	max			20 *±4.0*							

[a] *Data are arithmetic means unless stated as 'max'. 'Max' data are selected to be maxima If no 'max' value is given, the mean is also the maximum. See section 5 for definition*
[b] *See section 5 for definition*

Table 49. ***Radioactivity in crops remote from nuclear sites, 1995***[b]

Location	Material	No of samples[a]	Mean radioactivity concentration (wet), Bq kg^{-1}											
			^{3}H	^{14}C	^{90}Sr	Total Cs	^{210}Pb	^{210}Po	^{226}Ra	^{232}Th	Total U	^{238}Pu	$^{239}Pu + ^{240}Pu$	^{241}Am
Cheshire Macclesfield	Beetroot	1	<10	13 ±6.0	0.53 ±0.05	<0.20	0.12 ±0.02	0.066 ±0.009	0.091 ±0.006	0.020 ±0.006	0.09 ±0.019	<0.00020	0.00070 ±0.00040	0.00060 ±0.00050
	Leafy Green Veg.	1	26 ±3.0	<15	<0.20	<0.20 ±0.042	0.060 ±0.005	0.019 ±0.0040	0.0080	<0.0050	<0.0089	<0.00020	<0.00020	<0.00020
	Potatoes	1	<10	16 ±5.0	<0.20	<0.20	0.069 ±0.042	0.030 ±0.006	0.038 ±0.004	0.027 ±0.005	0.095 ±0.011	<0.00020	0.0013 ±0.0005	<0.00030
Clwyd Rhyl	Honey	1	<10	68 ±12	<0.20	<0.20	<0.038 ±0.018	0.030 ±0.006	0.0060 ±0.0030	<0.0050	<0.029	<0.00020	<0.00030	<0.00040
	Silage	1	<10	36 ±6.0	0.88 ±0.06	0.37 ±0.09	0.93 ±0.04	0.59 ±0.06	0.17 ±0.01	0.010 ±0.006	<0.13	<0.00030	0.0017 ±0.0009	0.0033 ±0.0018
	Damsons	1	<10	21 ±5.0	<0.20	<0.20	0.15 ±0.05	0.059 ±0.009	0.012 ±0.003	<0.0050	0.029	<0.00020	<0.00020	<0.00030 ±0.00030
Cornwall Bude	Fodder Beet	1	<10	14 ±6.0	0.53 ±0.05	<0.20	0.13 ±0.03	0.10 ±0.01	0.13 ±0.01	0.025 ±0.005	0.072 ±0.021	<0.00020	0.00080 ±0.00040	0.00090 ±0.00060
	Leafy Green Veg.	1	<10	13 ±3.0	1.8 ±0.1	<0.20	3.0 ±0.1	0.78 ±0.06	0.023 ±0.005	0.0060 ±0.0050	<0.045	<0.00020	<0.00020	<0.00030
Bodmin	Kale	1	<10	<15	1.8 ±0.1	0.72 ±0.09	-	-	-	-	-	<0.00020	<0.00020	<0.00040
	Turnips	1	<10	12 ±4.0	1.1 ±0.1	<0.20	-	-	-	-	-	<0.00040	<0.00020	<0.00040
Cumbria Keswick	Carrots/Swedes	1	<10	<15	0.48 ±0.04	0.35 ±0.08	-	-	-	-	-	<0.00020	0.0011 ±0.0004	0.00030 ±0.00030
	Leafy Green Veg.	1	<10	<15	0.50 ±0.04	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00060 ±0.00040
	Soft Fruit	1	<10	25 ±7.0	0.7 ±0.04	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00030 ±0.00030
Ambleside	Plums	1	<10	14 ±4.0	<0.20	0.23 ±0.08	0.12 ±0.06	0.041 ±0.007	0.0080 ±0.0030	<0.0050	<0.032	<0.00020	<0.00020	0.00040 ±0.00040
	Potatoes	1	<10	18 ±4.0	<0.20	0.35 ±0.07	<0.040	0.042 ±0.007	0.019 ±0.004	0.012 ±0.005	0.075 ±0.011	<0.00020	0.00050 ±0.00030	0.00030 ±0.00030
	Spinach	1	<10	<15	1.3 ±0.1	0.36 ±0.08	1.2 ±0.1	0.36 ±0.03	0.12 ±0.01	0.012 ±0.004	<0.052	<0.00020	0.00060 ±0.00030	0.00030 ±0.00030
Gloucestershire Cirencester	Leafy Green Veg.	1	<10	<15	0.48 ±0.04	<0.20	0.88 ±0.04	0.28 ±0.03	<0.0050	0.019 ±0.005	0.039 ±0.015	<0.00020	<0.00020	<0.00050
	Root Veg	1	<10	21 ±6.0	<0.20	<0.20	0.046 ±0.015	0.043 ±0.007	0.041 ±0.004	0.043 ±0.006	0.20 ±0.03	<0.00020	0.00030 ±0.00020	<0.00050
	Soft Fruit	1	<10	18 ±3.0	<0.20	<0.20	0.085 ±0.018	0.029 ±0.006	<0.0050	<0.0050	<0.0070	<0.00020	<0.00020	<0.00030
Humberside Hull	Sprouts	1	<10	<15	-	-	-	-	-	-	-	-	-	-
Driffield	Swede	1	<10	<15	0.28 ±0.04	<0.20	-	-	-	-	-	<0.00020	0.0024 ±0.0008	<0.00070
Lincolnshire Sleaford	Cabbage	1	<10	<15	<0.20	<0.20	-	-	-	-	-	<0.00020	0.00030 ±0.00020	0.00040 ±0.00040
	Plums	1	<10	<15	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00020
	Potatoes	1	<10	16 ±5.0	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00020
Norfolk Kings Lynn	Leafy Green Veg.	1	<10	16 ±4.0	<0.20	<0.20	0.18 ±0.03	0.092 ±0.011	0.0070 ±0.0040	<0.0050	0.12 ±0.02	<0.00020	<0.00020	0.00030 ±0.00020
	Root Veg.	1	<10	16 ±5.0	0.22 ±0.03	<0.20	<0.025	0.030 ±0.006	0.018 ±0.003	<0.0050	<0.042	<0.00020	<0.00020	0.00030 ±0.00030
	Soft Fruit	1	<10	15 ±5.0	<0.20	<0.20	<0.025	0.061 ±0.008	0.023 ±0.004	<0.0050	<0.034	<0.00030	<0.00020	0.00030 ±0.00030

Table 49. continued

Location	Material	No of samples[a]	Mean radioactivity concentration (wet), Bq kg^{-1}											
			^{3}H	^{14}C	^{90}Sr	Total Cs	^{210}Pb	^{210}Po	^{226}Ra	^{232}Th	Total U	^{238}Pu	$^{239}Pu + ^{240}Pu$	^{241}Am
Northamptonshire														
Kettering	Blackberries	1	<10	23 ±*4.0*	<0.20	<0.20	0.22 ±*0.06*	0.080 ±*0.011*	0.029 ±*0.006*	<0.0050	<0.012	<0.00020	<0.00020	0.00030 ±*0.00030*
	Leafy Green Veg.	1	<10	<15	<0.20	<0.20	0.10 ±*0.02*	0.031 ±*0.007*	<0.0050	<0.0050	<0.017	<0.00020	<0.00020	<0.00030
	Potatoes	1	<10	20 ±*4.0*	<0.20	<0.20	<0.040	0.020 ±*0.005*	0.023 ±*0.004*	0.040 ±*0.006*	0.069 ±*0.011*	<0.00020	<0.00020	0.00030 ±*0.00030*
Suffolk														
Ipswich	Leafy Green Veg.	1	<10	<15	0.47 ±*0.04*	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00050 ±*0.00040*
	Parsnips	1	<10	19 ±*4.0*	0.24 ±*0.04*	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00060 ±*0.00050*
	Root Veg	1	<10	19 ±*4.0*	0.24 ±*0.04*	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00060 ±*0.00050*
	Soft Fruit	1	<10	17 ±*4.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00030
Surrey														
Reigate	Carrots	1	<10	<15	0.23 ±*0.04*	<0.20	0.11 ±*0.03*	0.029 ±*0.005*	0.15 ±*0.01*	0.016 ±*0.004*	0.081 ±*0.011*	<0.00020	0.00090 ±*0.00040*	0.0032 ±*0.0014*
	Lettuce	1	<10	<15	0.24 ±*0.04*	<0.20	0.27 ±*0.04*	0.11 ±*0.02*	0.030 ±*0.004*	0.035 ±*0.007*	0.10 ±*0.01*	<0.00020	<0.00020	<0.0010
	Strawberries	1	<10	<15	<0.20	<0.20	0.23 ±*0.04*	0.092 ±*0.011*	0.075 ±*0.006*	0.0090 ±*0.0030*	0.036 ±*0.013*	<0.00030	<0.00020	0.00040 ±*0.00030*
Guildford	Leafy Green Veg.	1	<10	<15	<0.20	<0.20	0.16 ±*0.06*	0.054 ±*0.007*	0.031 ±*0.004*	0.027 ±*0.008*	0.20 ±*0.02*	<0.00020	0.00040 ±*0.00030*	<0.00040
	Root Veg.	1	<10	15 ±*5.0*	0.21 ±*0.04*	<0.20 ±*0.053*	0.054 ±*0.006*	0.034 ±*0.005*	0.021 ±*0.006*	0.016	-	<0.00020	<0.00020	<0.00020
	Soft Fruit	1	<10	16 ±*3.0*	<0.20	<0.20	0.13 ±*0.02*	0.05 ±*0.008*	0.039 ±*0.004*	<0.0050	<0.019	<0.00020	<0.00020	0.00030 ±*0.00030*
Newcastle	Tyneside Cabbage	1	<10	<15	0.29	<0.20 ±*0.04*	-	-	-	-	-	<0.00020	<0.00020	<0.00030
	Potatoes	1	<10	20 ±*6.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00040
Warwickshire														
Warwick	Apples	1	<10	15 ±*4.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00050 ±*0.00040*
	Blackberries	1	<10	19 ±*5.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	0.00030 ±*0.00030*
	Carrots	1	<10	<15	0.33 ±*0.04*	<0.20	-	-	-	-	0.071 ±*0.014*	<0.00020	<0.00020	0.00030 ±*0.00030*
	Sprouts	1	<10	<15	-	-	-	-	-	-	-	-	-	-
Wiltshire														
Swindon	Apples	1	<10	<15	<0.20	<0.20	0.052 ±*0.017*	0.028 ±*0.006*	0.0060 ±*0.0030*	<0.0050	<0.029	<0.00020	<0.00020	<0.00040
	Cabbage	1	<10	<15	0.41 ±*0.04*	<0.20	0.33 ±*0.03*	0.12 ±*0.01*	<0.0050	<0.0050	<0.044	<0.00020	<0.00020	<0.00050
	Carrots	1	<10	<15	0.22 ±*0.03*	<0.20	0.12 ±*0.02*	0.046 ±*0.007*	0.062 ±*0.006*	0.018 ±*0.004*	0.073 ±*0.017*	<0.00020	<0.00020	0.00040 ±*0.00030*
Salisbury	Grapes	1	<10	17 ±*4.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00020
	Leafy Green Veg.	1	<10	<15	1.2 ±*0.1*	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00030
	Sugar Beet	1	<10	<15	0.29 ±*0.03*	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00050
Wolverhampton														
Cotshall	Cabbage	1	<10	<15	0.56 ±*0.05*	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00030
	Damsons	1	<10	25 ±*4.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	<0.00020	<0.00020
	Potatoes	1	<10	20 ±*5.0*	<0.20	<0.20	-	-	-	-	-	<0.00020	0.00090 ±*0.00030*	<0.00030

- not analysed
[a] *see section 5 for definition*
[b] *Results are available for other artificial nuclides detectable by gamma spectrometry. All such results are less than the limit of detection*

Table 50. Radioactivity in sea water from the Irish Sea and Scottish waters, 1995

Location	No. of sampling observa-tions	Mean radioactivity concentration, Bq l^{-1}			
		^{3}H	^{99}Tc	^{134}Cs	^{137}Cs
Seascale	4	-	-	0.0074 ±*0.0017*	0.25 ±*0.002*
St Bees	4	13 ±*2.1*	0.48 ±*0.04*	0.0047 ±*0.0016*	0.23 ±*0.002*
Whitehaven	1	-	-	0.0017 ±*0.002*	0.31 ±*0.002*
Maryport	1	-	-	0.0027 ±*0.0015*	0.4 ±*0.002*
Silloth	1	-	-	0.0032 ±*0.0015*	0.62 ±*0.003*
Silecroft	1	-	-	*	0.0033 ±*0.0008*
Walney-west shore	4	12 ±*2.1*	-	0.0039 ±*0.0015*	0.059 ±*0.001*
Isle of Whithorn	1	-	-	*	0.13 ±*0.001*
Drummore	1	-	-	*	0.066 ±*0.001*
Half Moon Bay	1	-	-	0.0043 ±*0.0017*	0.38 ±*0.002*
Rossal (Fleetwood)	1	-	-	0.0044 ±*0.0017*	0.27 ±*0.002*
Ainsdale	1	-	-	0.0033 ±*0.0016*	0.21 ±*0.002*
New Brighton	1	-	-	0.0015 ±*0.0016*	0.13 ±*0.002*
Ross Bay	1	-	-	0.0027 ±*0.0015*	0.16 ±*0.002*
North of Larne	12	-	0.029 ±*0.002*	0.0017 ±*0.0014*	0.046 ±*0.001*
Seafield	4	8.6 ±*1.9*	-	0.0032 ±*0.0017*	0.34 ±*0.002*
Southerness	4	10 ±*2.0*	-	0.0040 ±*0.0016*	0.41 ±*0.002*
Knock Bay	4	*	-	0.0042 ±*0.0025*	0.063 ±*0.002*
Prestatyn	1	-	-	*	0.042 ±*0.001*
Llandudno	1	-	-	*	0.044 ±*0.001*
Cemaes Bay	1	-	-	*	0.014 ±*0.0008*
Holyhead	4	*	-	*	0.014 ±*0.0008*
Cape Wrath	4	-	-	*	0.018 ±*0.0008*
Pentland Firth	4	-	-	*	0.015 ±*0.0008*
Fair Isle	3	-	-	*	0.0076 ±*0.0008*
Aberdeen	4	-	-	*	0.013 ±*0.0008*

- *not analysed*
* *not detected by the method used*

Table 51. Extramural projects in support of the monitoring programmes

		Target completion date
1.	Radioactivity in terrestrial wild foods	Complete
2.	^{14}C in UK grown foods	"
3.	Natural radionuclides in beer	"
4.	^{210}Po and ^{210}Pb in UK terrestrial foods	"
5.	Inter-laboratory comparison of ^{210}Pb and ^{210}Po measurements in foodstuffs	Dec-96
6.	Radioactivity in tide washed pastures	Complete
7.	Radioactivity in UK produced beverages	"
8.	Evaluation of ion chromatagraphic separations for actinide elements in diet	"
9.	Development of a sensitive method for the determination of ^{35}S in food	"
10.	Database for nuclear operators environmental monitoring data	"
11.	Care and maintenance of radiocaesium samples	"
12.	^{35}S, ^{14}C and tritium in air, grass and crops	"
13.	Sensitivity analysis of critical group assessments	Mar-96
14.	Chernobyl radiocaesium in Cumbrian grass	Complete
15.	The dynamics of radionuclides in sheep	May-96
16.	Hot particles in the foodchain	Complete
17.	Collective dose determination from surveillance data	Sep-96
18.	Radionuclides in macrofungi	Feb-97
19.	Radionuclide analyses: landfill, industrial and diet	Mar-97
20.	Decision aiding tool to optimise surveillance programmes	Aug-97
21.	The radiological impact of free foods	Dec-97
22.	Quality control of foodstuff surveillance	Mar-98
23.	Food production near nuclear sites	Mar-98
24.	Dietary studies near nuclear installations	Mar-00
25.	Variability of natural nuclides in crops	Feb-98

APPENDIX 1. Monitoring of the marine environment near nuclear sites in Scotland, 1995

1.1 Introduction

This Appendix presents the results of the aquatic environmental monitoring programme carried out in Scotland during 1995 by staff of the Ministry of Agriculture, Fisheries and Food's (MAFF's) Directorate of Fisheries Research (DFR), Lowestoft. This programme was carried out on behalf of the Scottish Office to support statutory functions under the Radioactive Substances Act, 1993 (United Kingdom - Parliament, 1993). Its primary purposes are to verify the satisfactory control of liquid radioactive waste discharges and to ensure that the resulting public radiation exposure is within nationally-accepted limits.

To set the monitoring results from the regular programme in context, liquid radioactive discharges from Scottish nuclear establishments in 1995 are first summarised. The results for individual sites then follow. The information on the aquatic environment in the main text of this report give details of the methods of sampling, analysis and presentation and assessment of results. The programme for sites in Scotland is carried out with the same basis and to the same standards as that for sites in England and Wales. The programme in Scotland, taken with that in other areas discussed in the main text of this report, provides information on radioactivity covering the whole of the surface and coastal waters of the British Isles.

1.2 Discharges of radioactive waste

Table 1.1 lists the principal discharges of liquid radioactive waste from Scottish nuclear establishments during 1995. The locations of these establishments are shown in Figure 1.1. Table 1.1. also lists the discharge limits which are authorised. These are usually very much lower than the levels of activities which could be released without exceeding the dose limits which are recommended by the International Commission on Radiological Protection and embodied in national policy (United Kingdom - Parliament, 1995a). The percentages of the authorised limits taken up in 1995 are also stated in Table 1.1. No site discharged waste above the authorised limits in 1995.

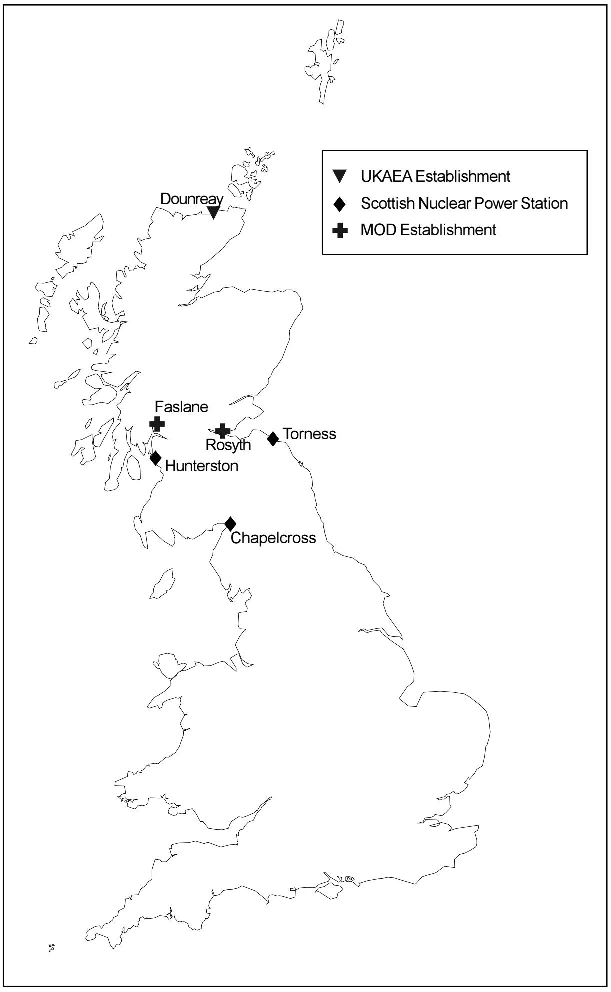

Figure 1.1. Principal sources of radioactive waste disposal in Scotland, 1995

1.3 Chapelcross, Annandale and Eskdale

At this establishment, BNFL operates a magnox-type nuclear power station. Liquid waste is discharged to the Solway Firth under authorisation from the Scottish Office. Discharges in 1995 were similar to those in 1994. Habits surveys have established that three groups of people could receive radiation exposures of potential importance. The first of these groups comprises fishermen who consume local seafood and are exposed to external radiation whilst tending stake nets. The second group are fishermen who receive skin exposures whilst handling nets and the third are wildfowlers who are exposed whilst on salt marshes. The scope of monitoring reflects these pathways. Samples of sea water and *Fucus vesiculosus*, as useful indicators, are also analysed. The results of monitoring in 1995 are presented in Tables 1.2(a) and (b).

Concentrations of artificial radionuclides in the Chapelcross vicinity are mostly due to Sellafield discharges, and the general levels of nuclides given in Table 1.2(a) are consistent with values expected at this distance from Sellafield. Concentrations of radiocaesium in 1995 were generally similar to, or less than, those in 1994. The total beta activity in *Fucus vesiculosus* increased due to increases in discharges, particularly of technetium-99, from Sellafield. The exposure of the critical group of fishermen who consume seafood and are exposed to external radiation over intertidal areas was 0.026 mSv in 1995 which is 3% of the dose limit of 1 mSv for members of the public. The exposure of the skin of local fishermen, including a component due to natural radiation was 0.088 mSv corresponding to less than 0.2% of the dose limit appropriate for exposures to skin of members of the public. Wildfowlers received a dose of 0.024 mSv. The magnitude of the Chapelcross discharges indicates that the local contribution to dose was a tiny fraction of these exposures, most of it being due to Sellafield discharges.

1.4 Dounreay, Caithness

Liquid radioactive waste discharges from this UKAEA establishment are made to the Pentland Firth under authorisation by the Scottish Office. Discharges include a minor contribution from the adjoining reactor site (Vulcan Naval Reactor Test Establishment) which is operated by the Ministry of Defence (Procurement Executive). Discharges from Dounreay in 1995 were generally similar to those in 1994 reflecting the campaigns of reprocessing of reactor fuel. Monitoring in 1995 continued to include sampling of fish and shellfish from the area of the Dounreay outfall and other materials further afield, associated beta and gamma dose rate measurements and a survey in Sandside Bay for particulate contamination. The results are presented in Tables 1.3(a) and (b). No particulate contamination was found in Sandside Bay.

Habits surveys have confirmed the existence of four potentially critical exposure pathways, three of which involve external irradiation. The first of these is due to radioactivity adsorbed mainly on fine particulate matter becoming entrained on fishing gear which is regularly handled. This results in skin dose, mainly from beta particles, to the hands and forearms of fishermen. The most exposed group is represented by a small number of people who operate a salmon fishery from Sandside Bay, close to Dounreay. The skin exposure of these fishermen has been assessed including a component due to natural radiation. The dose in 1995 was 0.17 mSv, or less than 0.4% of the dose limit of 50 mSv for skin exposures.

The second potentially critical pathway arises also from the uptake of radioactivity by particulate material which accumulates in rocky areas of the foreshore and presents a potential source of exposure, mainly to gamma radiation, of those who visit these areas. In 1995, monitoring of sludge at Oigin's Geo showed decreased concentrations of radionuclides compared with 1994. However, there is known to be significant variability in these concentrations. The more important measurements of gamma dose rates above areas of the foreshore remained unchanged. Public radiation exposure via this pathway remained low, at 0.008 mSv or 0.8% of the dose limit of 1 mSv.

The third potentially critical pathway involves internal exposure of consumers of locally-collected fish and shellfish; fish, crabs, lobsters and winkles from the outfall area are sampled to enable this pathway to be kept under review. Additionally, sea water and seaweed were sampled as indicator materials. Concentrations of radionuclides in 1995 were generally similar to those for 1994, although there were some small increases observed. Despite these, exposures from consumption of fish and shellfish continued to be low: for high-rate consumers the radiation dose was less than 0.005 mSv or 0.5% of the dose limit of 1 mSv.

The fourth potential critical pathway is due to consumption of molluscs and external exposure during collection. Gamma dose rates were measured over collecting areas and winkles were analysed for their radioactivity content. Gamma dose rates over the main collecting areas were unchanged in 1995 and the radiation dose due to a combination of consumption of molluscs and external exposure during collection was still low at 0.030 mSv or 3% of the dose limit of 1 mSv. This pathway was the critical one at Dounreay in 1995.

1.5 Hunterston, Cunninghame

This establishment comprises 'A' and 'B' stations; the 'A' station was designed for magnox-type reactors and the 'B' station for AGRs. The 'A' station ceased power production at the end of March 1990. Liquid radioactive waste discharges are made to the Firth of Clyde under authorisation of the Scottish Office. A recent habits survey has confirmed that there are two pathways which contribute to the radiation exposure of the most exposed group: fish and shellfish consumption leading to internal irradiation, and occupancy of intertidal areas leading to external exposure. Therefore, the main part of the monitoring programme comprises sampling of fish and shellfish and measurement of gamma dose rate on the foreshore. Samples of sand are also analysed in support of the gamma dose rate measurements and sea water and Fucus seaweed are analysed as indicator materials. The results of monitoring in 1995 are shown in Tables 1.4(a) and (b). The concentrations of artificial radioactivity in this area are predominantly due to Sellafield discharges, the general values being consistent with those to be expected at this distance from Sellafield. Small concentrations of activation products such as manganese-54 were probably due to discharges from the site; however, these were of negligible radiological significance. In 1995, the exposure, including external radiation, of members of the most exposed group of fish and shellfish consumers near Hunterston was low, at 0.018 or 2% of the dose limit of 1 mSv.

1.6 Torness, East Lothian

This station, which is powered by two AGRs, came into operation at the end of 1987. Discharges of radioactive wastes to the North Sea are authorised by the Scottish Office. A habits survey has shown that potentially critical pathways for radiation exposure of the public are internal irradiation from consumption of local fish and shellfish and external exposure from occupancy of intertidal areas during leisure activities and whilst collecting shellfish. These pathways form the basis of the regular monitoring programme. Samples of fish and shellfish are collected and analysed, and samples of sea water and *Fucus vesiculosus* are monitored as indicator materials. Measurements are also made of gamma dose rates over intertidal areas, supported by analyses of sediment, and beta dose rates on fishing gear.

Results of this monitoring in 1995 are shown in Tables 1.5(a) and (b). Concentrations of artificial radionuclides were mainly due to the distant effects of Sellafield discharges and to fallout, though trace levels of activation products were likely to have been due to discharges from the station. In 1995, the group of fish and shellfish consumers and the group subject to external radiation both received very low exposures at less than 0.005 mSv, or 0.5% of the dose limit of 1 mSv. The beta radiation from fishermen's nets and pots was typical of that due to natural radiation.

1.7 Naval establishments

Liquid wastes containing small quantities of radioactivity are discharged from the establishments at Faslane and Rosyth under authorisation of the Scottish Office (Table 1.1). DFR carry out monitoring programmes near these establishments and also Holy Loch in surveillance of the effects of past discharges.

Public radiation exposures due to the effects of any discharges from these establishments are primarily due to external radiation from sediments, the nuclide of main importance being cobalt-60. Regular assessments of doses to most exposed groups take account of the effects of discharges from other nuclear establishments (e.g. Sellafield) as well as exposure pathways additional to external radiation, such as any consumption of fish and shellfish. Measurements of gamma dose rates are regularly carried out near all establishments; these are supported by analyses of sediments. Marine foodstuffs and sea water are also analysed where appropriate.

Results of monitoring in 1995 are presented in Tables 1.6(a) and (b). The small concentrations of cobalt-60 mainly reflect discharges from the establishments; levels of other radionuclides are mainly due to discharges from Sellafield and to weapons-test fallout. Gamma dose rates over intertidal sediments, directly measured using portable instruments, were generally difficult to distinguish from the natural background. The gamma dose rate at Carnban boatyard near Faslane increased in 1995 but this was due to direct radiation from a source of stored waste, and not to the effects of liquid waste discharges. In 1995, the exposure of most exposed groups, including the effects of other sources and taking account of consumption of marine foods and occupancy times, continued to remain low near these naval establishments, at less than 0.020 mSv $year^{-1}$. This represents less than 2% of the dose limit of 1 mSv.

1.8 Conclusions

- Discharges of liquid radioactive wastes from major nuclear sites in Scotland were controlled by the Scottish Office using powers in the Radioactive Substances Act, 1993. Discharges from all sites in 1995 were within the authorised limits.

- MAFF operated a radioactivity monitoring programme to check the safety of these discharges on behalf of the Scottish Office. The programme considered all relevant pathways of exposure and included detection of beta and gamma dose rates in the environment and the analyses of samples of seafood and other materials from the environment. Dose rates and activity concentrations were generally similar in 1995 to those in 1994.

- Public radiation exposures from discharges of liquid radioactive waste in 1995 are presented in Table 1.7 and Figure 1.2. Doses were similar to those in 1994 and were all well within the dose limit of 1 mSv for members of the public or the skin dose limit of 50 mSv as appropriate.

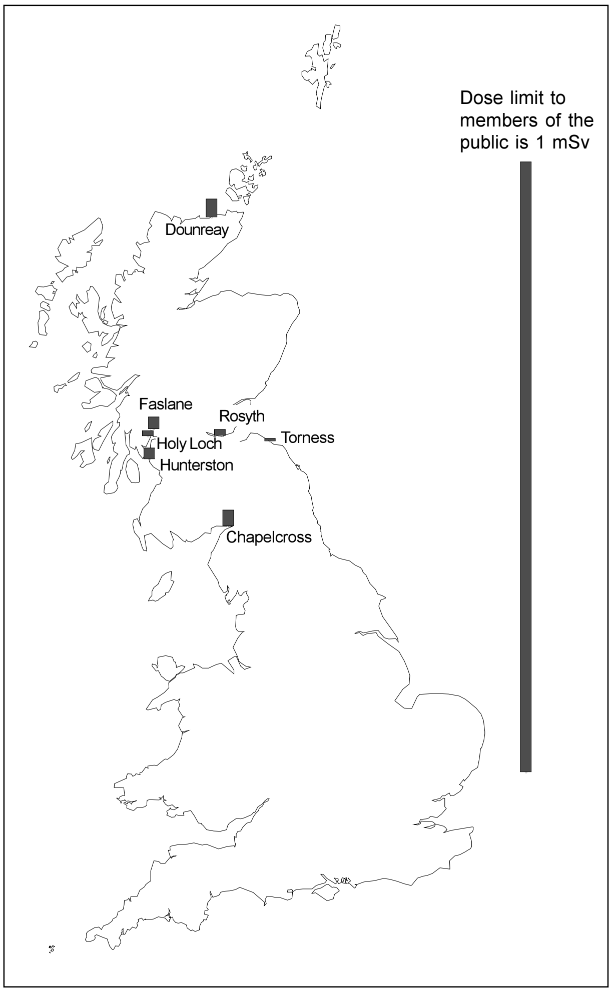

Figure 1.2. Radiation exposures in Scotland due to liquid radioactive waste discharges, 1995. (Historic discharges from Sellafield contribute to exposures at Scottish sites)

Table 1.1. Principal discharges of liquid radioactive waste from nuclear establishments in Scotland, 1995

Establishment	Radioactivity	Discharge limit (annual equivalent), TBq	Discharges during 1995	
			TBq[a]	% of limit[b]
British Nuclear Fuels plc				
Chapelcross	Total alpha	0.1	$6.61\ 10^{-4}$	<1
	Total beta[c]	25	0.158	<1
	Tritium	5.5	0.504	9.2
United Kingdom Atomic Energy Authority				
Dounreay	Total alpha[d]	0.75	0.0856	11
	Total beta[c]	110	6.98	6.3
	Tritium	130	1.09	<1
	Cobalt-60	1	0.0270	2.7
	Strontium-90	12	0.604	5.0
	Zirconium-95+Niobium-95	6	0.133	2.2
	Ruthenium-106	12	0.758	6.3
	Silver-110m	0.4	0.0060	1.5
	Caesium-137	50	3.72	7.4
	Cerium-144	12	0.0331	<1
	Plutonium-241	15	0.548	3.7
	Curium-242	1	0.0065	<1
Scottish Nuclear Ltd				
Hunterston				
'A' Station	Total activity[c]	2	0.150	7.5
	Tritium	5	0.0413	<1
'B' Station	Total activity[c,e]	3.7	0.0235	<1
	Tritium	1480	449	30
	Sulphur-35	26	1.70	6.5
Torness	Total alpha	0.0045	0.00000932	<1
	Beta activity[c,e,f]	0.45	0.00163	<1
	Tritium	1200	270	23
	Sulphur-35	10	0.0417	<1
	Cobalt-60	0.05	0.000665	1.3
Ministry of Defence				
Faslane	Alpha activity	$2.0\ 10^{-4}$	$1.4\ 10^{-5}$	7
	Beta activity[c,f]	$5.0\ 10^{-4}$	$3.11\ 10^{-4}$	62
	Tritium	1	0.0939	9.4
	Cobalt-60	$5.0\ 10^{-4}$	$2.03\ 10^{-4}$	40
Rosyth[g]	Total alpha	$1.0\ 10^{-6}$	$4.96\ 10^{-7}$	50
	Beta activity[c,f]	0.01	$2.62\ 10^{-4}$	2.6
	Tritium	0.01	0.00652	65
	Cobalt-60	0.055	$7.11\ 10^{-4}$	1.3

[a] *Some discharges are upper estimates because they include 'less than' data derived from analyses of effluents at limits of detection. Data quoted to 3 significant figures except where fewer significant figures are provided in source documents.*
[b] *Data quoted to 2 significant figures except when values are less than 1%*
[c] *Excluding tritium*
[d] *Excluding curium-242*
[e] *Excluding sulphur-35*
[f] *Excluding cobalt-60*
[g] *Discharges are made by Babcock Rosyth Defence Ltd*

Table 1.2(a). Radioactivity in seafood and the environment near Chapelcross nuclear power station, 1995

Material	Location[b]	No. of sampling observa-tions[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																		
			^{3}H	^{14}C	^{60}Co	^{90}Sr	^{99}Tc	^{106}Ru	^{110m}Ag	^{125}Sb	^{134}Cs	^{137}Cs	^{154}Eu	^{155}Eu	^{238}Pu	$^{239}Pu+^{240}Pu$	^{241}Pu	^{241}Am	^{242}Cm	$^{243}Cm+^{244}Cm$	Total beta
Flounder	Inner Solway	4	-	50 *±8.3*	*	0.042 *±0.002*	1.0 *±0.1*	*	*	*	*	28 *±0.8*	*	*	0.0038 *±0.0001*	0.020 *±0.0006*	-	0.031 *±0.0006*	0.000026 *±0.000014*	0.000051 *±0.000012*	-
Seatrout	“	1	-	-	*	-	-	*	*	*	*	3.3 *±0.5*	*	*	0.00044 *±0.00005*	0.0021 *±0.0001*	-	0.0032 *±0.0002*	*	0.0000080 *±0.0000059*	-
Salmon	“	1	-	-	*	-	-	*	*	*	*	0.85 *±0.17*	*	*	-	-	-	*	-	-	-
Shrimps	“	4	-	-	*	0.16 *±0.01*	2.5 *±0.2*	*	0.08 *±0.06*	*	*	12 *±0.3*	*	*	0.0036 *±0.0002*	0.019 *±0.0006*	-	0.032 *±0.001*	*	*	-
Winkles	Southerness	4	-	-	0.75 *±0.14*	1.9 *±0.1*	430 *±34*	1.9 *±1.1*	2.0 *±0.3*	0.61 *±0.35*	*	12 *±0.2*	0.08 *±0.13*	*	0.88 *±0.03*	4.3 *±0.1*	54 *±1.2*	7.3 *±0.2*	0.015 *±0.013*	0.014 *±0.007*	-
Fucus vesiculosus	Pipeline	4	-	-	0.56 *±0.13*	-	2200 *±200*	*	*	0.11 *±0.11*	*	27 *±0.3*	*	0.30 *±0.20*	0.65 *±0.03*	3.3 *±0.1*	-	3.7 *±0.1*	0.0063 *±0.0051*	0.0055 *±0.0029*	1500
Mud	Bladnoch	4	-	-	3.3 *±0.9*	-	-	25 *±8.3*	*	3.7 *±2.5*	0.91 *±0.84*	470 *±3.9*	6.1 *±2.1*	4.3 *±2.4*	-	-	-	320 *±7.8*	-	-	-
Mud and sand	Pipeline	4	-	-	1.2 *±0.45*	-	-	10 *±6.4*	*	0.72 *±0.94*	0.11 *±0.26*	280 *±2.5*	1.3 *±0.5*	0.74 *±0.43*	9.1 *±0.6*	46 *±1.5*	-	73 *±2.3*	*	0.074 *±0.055*	-
Sea water	“	4	4.3 *±0.7*	-	-	-	-	-	-	-	0.0032 *±0.0017*	0.34 *±0.002*	-	-	-	-	-	-	-	-	-
“	Southerness	4	10 *±1.9*	-	-	-	-	-	-	-	0.0040 *±0.0020*	0.41 *±0.002*	-	-	0.00045 *±0.00002*	0.0023 *±0.0001*	-	0.0021 *±0.0001*	0.000001 *±0.000001*	0.0000035 *±0.0000016*	-

- not analysed
** not detected by the method used*
[a] *Except for sea water where units are Bq l^{-1} and for sediment where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *see section 5 for definition*

Table 1.2(b). Monitoring of radiation dose rates near Chapelcross, 1995

Location	Ground type	No. of sampling observa-tions[a]	µSv h^{-1}
Beta dose rates on nets			
Seafield	Stake nets	3	0.35
Gamma dose rates at 1 m over intertidal areas			µGy h^{-1}
Seafield	Mud and sand	4	0.082
“	Salt marsh	4	0.090
Battle Hill	Mud and sand	4	0.084
Browhouses	“	3	0.11
“	Mud, sand and stones	1	0.11
Dornoch Brow	Mud and sand	2	0.086
“	Salt marsh	4	0.095
Powfoot	Mud and sand	4	0.078
Priestside Bank	Salt marsh	4	0.084
“ [b]	“	4	0.087
Southerness	Winkle bed	2	0.064

[a] *See section 5 for definition*
[b] *15 cm above subsrate*

Table 1.3(a). Radioactivity in seafood and the environment near Dounreay, 1995

Material	Location[b]	No. of sampling observa-tions[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}										
			^{3}H	^{14}C	^{54}Mn	^{58}Co	^{60}Co	^{95}Zr	^{95}Nb	^{99}Tc	^{106}Ru	^{110m}Ag	^{125}Sb
Cod	Pipeline	4	-	18 ±*6.9*	*	*	*	*	*	-	*	*	*
Crabs	"	4	-	-	*	*	*	*	*	-	*	0.55 ±*0.14*	*
Lobsters	"	4	-	-	*	*	0.12 ±*0.05*	*	*	-	*	*8.2* ±*0.5*	*
Winkles	Brims Ness	4	-	-	0.05 ±*0.04*	0.07 ±*0.06*	0.87 ±*0.18*	*	*	-	1.4 ±*1.0*	19 ±*0.58*	*
"	Sandside Bay	4	-	-	0.03 ±*0.04*	0.04 ±*0.04*	0.82 ±*0.11*	*	*	-	0.78 ±*0.76*	19 ±*0.36*	0.06 ±*0.07*
Sludge	Oigins Geo	3	-	-	68 ±*4.1*	18 ±*3.8*	120 ±*5.5*	14 ±*5.0*	9.3 ±*4.2*	-	2300 ±*53*	97 ±*7.3*	290 ±*13*
Sand	Sandside Bay	4	-	-	*	*	0.12 ±*0.14*	*	*	-	*	*	*
Fucus vesiculosus	"	4	-	-	0.12 ±*0.06*	0.07 ±*0.04*	0.94 ±*0.09*	0.04 ±*0.04*	0.03 ±*0.03*	250 ±*20*	0.50 ±*0.37*	1.2 ±*0.1*	0.04 ±*0.05*
"	Brims Ness	4	-	-	0.10 ±*0.07*	0.09 ±*0.06*	1.0 ±*0.1*	0.13 ±*0.08*	0.12 ±*0.13*	-	0.53 ±*0.36*	0.94 ±*0.15*	*
Sea water	Sandside Bay	4	*	-	-	-	-	-	-	-	-	-	-
Dry cloths		71	-	-	-	-	-	-	-	-	-	-	-

Material	Location[b]	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu	^{155}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm	Total alpha	Total beta	Total gamma
Cod	Pipeline	*	0.77	* ±*0.06*	*	*	0.00013	0.00065 ±*0.00002*	0.0011 ±*0.00005*	*	0.0000024 ±*0.00005*	-	- ±*0.000002*	-
Crabs	"	0.05 ±*0.05*	0.31 ±*0.09*	*	*	*	0.0037 ±*0.0001*	0.012 ±*0.0003*	0.017 ±*0.0003*	0.0022 ±*0.0001*	0.00030 ±*0.00003*	-	-	-
Lobsters	"	*0.06* ±*0.04*	0.77 ±*0.21*	*	*	*	0.014 ±*0.0004*	0.036 ±*0.001*	0.16 ±*0.003*	0.010 ±*0.0004*	0.0033 ±*0.0001*	-	-	-
Winkles	Brims Ness	0.05 ±*0.04*	0.41 ±*0.09*	0.17 ±*0.21*	*	*	0.14 ±*0.01*	0.40 ±*0.01*	0.39 ±*0.011*	0.030 ±*0.004*	0.0068 ±*0.0010*	-	-	-
"	Sandside Bay	0.04 ±*0.06*	0.47 ±*0.10*	0.06 ±*0.10*	*	0.02 ±*0.05*	0.13 ±*0.005*	0.39 ±*0.01*	0.36 ±*0.01*	0.036 ±*0.006*	0.0058 ±*0.0012*	-	-	-
Sludge	Oigins Geo	7.9 ±*3.0*	210 ±*4.7*	73 ±*11*	17 ±*6.1*	21 ±*4.7*	250 ±*4.5*	710 ±*17*	540 ±*9.6*	5.9 ±*1.3*	2.4 ±*0.5*	-	-	-
Sand	Sandside Bay	*	5.3 ±*0.3*	* ±*0.6*	1.1 ±*0.6*	1.3 ±*0.2*	2.6 ±*0.4*	10 ±*0.3*	9.4 ±*0.032*	0.089 ±*0.02*	0.12	-	-	-
Fucus vesiculosus	"	0.15 ±*0.06*	1.4 ±*0.07*	0.08 ±*0.08*	*	0.06 ±*0.05*	-	-	0.23 ±*0.12*	-	-	-	410	-
"	Brims Ness	0.06 ±*0.06*	0.96 ±*0.08*	0.32 ±*0.17*	0.02 ±*0.03*	0.11 ±*0.09*	-	-	0.32 ±*0.15*	-	-	-	-	-
Sea water	Sandside Bay	*	0.03 ±*0.0009*	-	-	-	-	-	-	-	-	-	-	-
Dry cloths		-	-	-	-	-	-	-	-	-	-	0.16 ±*0.15*	0.99 ±*0.91*	0.47 ±0.45

\- *not analysed*
* *not detected by the method used*
[a] *Except for sea water where units are Bq l^{-1}, and for sediment where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *See section 5 for definition*

Table 1.3(b). Monitoring of radiation dose rates near Dounreay, 1995

Location	Ground type	No. of sampling observa-tions[a]	μGy h^{-1}
Gamma dose rates at 1 m over substrate			
Oigins Geo	Intertidal sediment	4	0.15
Sandside Bay	Sand	1	0.074
"	Winkle bed	4	0.15
"	Net store	1	0.097
Castletown Harbour	Mud	2	0.077
Beta dose rates on fishing gear			μSv h^{-1}
Sandside Bay	Gill nets	1	0.18
Pipeline offshore	Pots	1	0.35

[a] *See section 5 for definition*

Table 1.4(a). Radioactivity in seafood and the environment near Hunterston nuclear power station, 1995

Material	Location[b]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}																
			^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{110m}Ag	^{124}Sb	^{134}Cs	^{137}Cs	^{155}Eu	^{238}Pu	$^{239+240}Pu$	^{241}Am	^{242}Cm	$^{243+244}Cm$	Total Beta
Cod	Millport	2	-	*	*	*	*	*	*	*	*	2.9 ±0.1	*	-	-	*	-	-	-
Saithe	"	1	-	*	*	*	*	*	*	*	*	5.6 ±0.2	*	-	-	*	-	-	-
Crabs	"	2	-	*	*	*	*	*	*	*	*	0.75 ±0.12	*	0.0062 *±0.0002*	0.03 *±0.0005*	0.034 *±0.0008*	*	0.00012 *±0.00003*	-
Nephrops	"	2	-	*	*	*	*	*	*	*	*	3.3 ±0.1	*	-	-	*	-	-	-
Velvet swimming crabs	Largs	1	-	*	*	*	*	*	*	*	*	0.39 *±0.20*	*	-	-	*	-	-	-
Lobsters	"	1	-	*	*	*	*	*	*	*	*	0.62 *±0.25*	*	-	-	*	-	-	-
Oysters	Fairlie	1	-	*	0.25 *±0.06*	*	0.23 *±0.06*	0.19 *±0.09*	0.82 *±0.10*	*	*	0.66 *±0.05*	*	-	-	*	-	-	-
Winkles	Pipeline	2	-	21 *±9.6*	6.0 *±0.2*	0.39 *±0.23*	3.6 *±0.2*	0.52 *±0.25*	6.3 *±0.3*	*	*	1.2 *±0.1*	0.06 *±0.08*	0.048 *±0.001*	0.18 *±0.003*	0.083 *±0.002*	0.002 *±0.0005*	0.0029 *±0.0003*	-
Fucus spiralis	"	2	-	3.8 *±0.9*	7.5 *±0.1*	1.1 *±0.09*	6.0 *±0.1*	0.60 *±0.12*	2.3 *±0.1*	0.11 *±0.06*	0.13 *±0.09*	4.2 *±0.1*	*	-	-	0.046 *±0.042*	-	-	350
Sand	"	2	-	*	7.9 *±0.4*	*	1.5 *±0.3*	*	*	*	*	12 *±0.5*	0.32 *±0.34*	-	-	0.29 *±0.17*	-	-	-
Sea water	"	12	3.1 *±1.9*	-	-	-	-	-	-	-	0.002 *±0.002*	0.06 *±0.001*	-	-	-	-	-	-	-

- not analysed
** not detected by the method used*
[a] *Except for sea water where units are Bq l^{-1} and for sediment where dry concentrations apply*
[b] *Landing point or sampling area*
[c] *See section 5 for definition*

Table 1.4(b). Monitoring of radiation dose rates near Hunterston nuclear power station, 1995

Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas			
0.5 km north of pipeline	Sand	2	0.055
0.5 km south of pipeline	Sand and stones	2	0.073
Ardrossan	Mud and sand	1	0.067
Bogside flats	Saltmarsh	2	0.071

[a] *See section 5 for definition*

Table 1.5(a). Radioactivity in seafood and the environment near Torness nuclear power station, 1995

Material	Location[b]	No. of sampling observ-ations[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}												
			^{3}H	^{54}Mn	^{60}Co	^{110m}Ag	^{125}Sb	^{137}Cs	^{155}Eu	^{238}Pu	$^{239+240}Pu$	^{241}Am	^{242}Cm	$^{243+244}Cm$	Total beta
Cod	Pipeline	2	-	*	*	*	*	1.0 *±0.1*	*	-	-	-	-	-	-
Crabs	Cove	2	-	*	*	*	*	0.09 *±0.08*	*	-	-	-	-	-	-
Lobsters	"	1	-	*	*	*	*	0.23 *±0.23*	*	-	-	-	-	-	-
Nephrops	Dunbar	4	-	*	*	*	*	0.62 *±0.10*	*	0.00071 *±0.00005*	0.0039 *±0.0001*	0.0061 *±0.0002*	0.000018 *±0.000014*	0.000027 *±0.00001*	-
Winkles	Pipeline	1	-	*	0.43 *±0.29*	1.6 *±0.6*	*	0.51 *±0.25*	*	-	-	-	-	-	38
Fucus vesiculosus	"	2	-	0.27 *±0.08*	0.97 *±0.10*	0.76 *±0.08*	*	0.62 *±0.08*	*	-	-	-	-	-	290
Mud	Eyemouth Harbour	1	-	*	*	*	*	32 *±0.5*	0.73 *±0.66*	-	-	-	-	-	-
Mud and sand	Dunbar inner harbour	2	-	*	*	*	*	19 *±0.7*	1.5 *±0.9*	-	-	0.43 *±0.44*	-	-	-
"	Barns Ness	1	-	*	*	*	0.48 *±0.34*	9.8 *±0.4*	1.9 *±0.5*	-	-	-	-	-	-
Sand	Thornton Loch Beach	2	-	*	*	*	*	3.1 *±0.3*	0.41 *±0.37*	-	-	-	-	-	-
Seawater	Pipeline	12	3.4 *±1.3*	-	-	-	-	0.016 *±0.001*	-	-	-	-	-	-	-

- *not analysed*
* *not detected by the method used*
[a] *except for sea water where units are Bq l^{-1} and for sediment where dry concentrations apply*
[b] *landing point or sampling area*
[c] *see section 5 for definition*

Table 1.5(b). Monitoring of radiation dose rates near Torness, 1995

Location	Ground type	No. of sampling observa-tions[a]	µSv h^{-1}
Beta dose rates on nets			
Cove	Pots	2	0.083
Dunbar Harbour	Nets	3	0.055
Gamma dose rates at 1 m over intertidal areas			µGy h^{-1}
Barns Ness	Mud, sand and stones	1	0.056
"	Mud and sand	1	0.066
Skateraw Harbour	Sand	1	0.052
"	Sand and stones	1	0.062
Thornton Loch Beach	Sand	2	0.057
Eyemouth Harbour	Mud and sand	1	0.082
Dunbar Inner Harbour	"	1	0.071
"	Mud	1	0.062
St Abbs	Mud and sand	2	0.079

[a] *See section 5 for definition*

Table 1.6(a). Radioactivity in seafood and the environment near naval establishments in Scotland, 1995

Material	Location[b]	No. of sampling observa-tions[c]	Mean radioactivity concentration (wet)[a], Bq kg^{-1}					
			^{3}H	^{60}Co	^{125}Sb	^{131}I	^{137}Cs	^{155}Eu
Faslane								
Mud, sand and stones	Carnban boatyard	2	-	3.1 *±0.7*	0.5 *±0.5*	*	30 *±1.0*	*
Sea water	"	1	*	-	-	-	-	-
Holyloch								
Mud	Mid-Loch	1	-	0.75 *±0.26*	*	*	21 *±0.7*	1.4 *±1.0*
Rosyth								
Crabs	East of dockyard	2	-	*	*	*	0.22 *±0.14*	*
Fucus vesiculosus	"	2	-	*	*	0.81 *±0.24*	0.63 *±0.10*	*
Mud and sand	Blackness Castle	2	-	*	*	*	28 *±1.2*	1.7 *±1.2*
"	West of dockyard	2	-	*	*	*	21 *±0.7*	2.0 *±0.9*
Mud	East of dockyard	2	-	*	*	*	28 *±1.3*	0.75 *±0.50*
"	Port Edgar	2	-	0.17 *±0.15*	*	*	31 *±1.1*	0.90 *±0.46*
Sand	Pettycur	2	-	*	*	*	1.3 *±0.2*	0.15 *±0.23*

\- *not analysed*
* *not detected by the method used*
[a] *Except for sea water where units are Bq l^{-1}, and for sediment where dry concentrations apply*
[b] *Landing point or sampling area.*
[c] *See section 5 for definition*

Table 1.6(b). Monitoring of radiation dose rates near naval establishments in Scotland, 1995

Establishment	Location	Ground type	No. of sampling observa-tions[a]	µGy h^{-1}
Gamma dose rates at 1 m over intertidal areas				
Faslane	Gareloch Head	Mud, sand and stones	2	0.059
"	Gulley Bridge Pier	Sand and stones	2	0.068
"	Rhu Narrows	Mussel bed	2	0.059
"	Rosneath	Sand and gravel	2	0.067
"	Carnban boatyard	Mud, sand and stones	2	0.10
Holy Loch	North Sandbank	Mud and sand	1	0.075
"	Kilmun Pier	Sand and stones	1	0.070
"	Mid-Loch	Mussel bed	1	0.056
Rosyth	Blackness Castle	Mud and sand	1	0.062
"	"	Mud	1	0.065
"	Pettycur	Sand	2	0.055
"	East of Dockyard	"	1	0.059
"	Port Edgar	Mud	2	0.068
"	West of Dockyard	Mud and sand	2	0.079

[a] *See section 5 for definition*

Table 1.7 Estimates of public radiation exposure from discharges of liquid radioactive waste in Scotland, 1995

Establishment	Radiation exposure pathway	Critical group	Exposure[b], mSv
British Nuclear Fuels plc			
Chapelcross	Fish and shellfish consumption and external	Local fishermen	0.026
	External	Wildfowlers	0.024
	Handling of fishing gear	Local fishermen	0.088[a]
United Kingdom Atomic Energy Authority			
Dounreay	Handling of fishing gear	Local fishermen	0.17[a]
	External	Local community	0.008
	Fish and shellfish consumption	Local fishing community	<0.005
	Mollusc consumption and external	Mollusc collectors	0.030
Scottish Nuclear Ltd			
Hunterston	Fish and shellfish consumption and external	Local fishing community	0.018
Torness	Fish and shellfish consumption	Local fishing community	<0.005
	External	Local community	<0.005
Naval Establishments			
Faslane	External	Boatyard workers	0.020[c]
Holy Loch	External	Local community	0.009
Rosyth	External	Local community	0.010

[a] *Exposure to skin including a component due to natural sources of beta radiation, to be compared with the dose limit of 50 mSv*
[b] *Unless otherwise stated, represents the committed effective dose calculated using the methodology of ICRP-60, to be compared with the dose limit of 1 mSv. Includes the far-field effects of discharges from BNFL Sellafield.*
[c] *Includes the effects of direct radiation from a waste store*

APPENDIX 2. Abbreviations

AGR	Advanced Gas-Cooled Reactor
ALARA	As Low as Reasonably Achievable
BPM	Best Practicable Means
BNFL	British Nuclear Fuels plc
CARE	Centre for Analytical Research in the Environment
DFR	Directorate of Fisheries Research (MAFF)
EARP	Enhanced Actinide Removal Plant
FARM	Food and Agriculture Monitoring Programme
GDL	Generalised Derived Limit
G-M	Geiger-Muller
IAEA	International Atomic Energy Agency
HMIP	Her Majesty's Inspectorate of Pollution
ICRP	International Commission on Radiological Protection
LoD	Limit of Detection
MAFF	Ministry of Agriculture, Fisheries and Food
MRL	Minimum reporting level
ND	Not detected
NEA	Nuclear Energy Agency
NRPB	National Radiological Protection Board
OECD	Organisation for Economic Co-operation and Development
OSPAR	Oslo and Paris CommissionPWR Pressurised Water Reactor
RSD	Radiological Safety Division (MAFF)
SGHWR	Steam Generating Heavy Water Reactor
THORP	Thermal Oxide Reprocessing Plant
TRAMP	Terrestrial Radioactivity Monitoring Programme
UKAEA	United Kingdom Atomic Energy Authority
VLA	Veterinary Laboratories Agency

APPENDIX 3. Consumption, handling and occupancy rates

This appendix gives the consumption, handling and occupancy rate data used in the assessment of exposures. Consumption rates for terrestrial foods are given in Table 3.1. These are based on national statistics and are taken to apply at each site. Site-specific data for aquatic pathways based on local surveys are given in Table 3.2.

Table 3.1 Consumption rates for terrestrial foods

Food Group	Consumption rates (kg y^{-1})					
	Average			Above average consumption rate*		
	Adult	10 year old	Infant	Adult	10 year old	Infant
Beef	15	15	3	45	30	10
Cereals	50	45	15	100	75	30
Eggs	8.5	6.5	5.	25	20	15
Fruit	20	15	9	75	50	35
Game	6	4	1	15	7.5	2
Green Vegetables	15	6	3.5	45	20	10
Honey	2.5	2	2	9.5	7.5	7.5
Lamb	8	4	1	25	10	3
Legumes	20	8	3	50	25	10
Milk	95	110	130	240	240	320
Mushrooms	3	15	0.5	10	4.5	1.5
Nuts	3	15	1	10	7	2
Offal	5.5	3	1	20	10	5.5
Pork	15	8.5	1.5	40	25	5.5
Potatoes	50	45	10	120	85	35
Poultry	10	5.5	2	30	15	5.5
Root crops	10	6	5	40	20	15
Wild fruit	7	3	1	25	10	2

* *These rates are the 97.5th percentile of the distribution across all consumers*

Table 3.2 Consumption, handling and occupancy rates for aquatic pathways

Site	Group[a]	Rates
Aldermaston		1 kg y^{-1} pike 360 h y^{-1} over riverbank
Amersham		1 kg y^{-1} pike 1350 h y^{-1} over riverbank
Barrow		1000 h y^{-1} over mud and sand
Berkeley and Oldbury		17 kg y^{-1} flounders 4.9 kg y^{-1} shrimps 980 h y^{-1} over mud
Bradwell	A	75 kg y^{-1} fish 5.0 kg y^{-1} crustaceans 2000 h y^{-1} over mud
	B	4.7 kg y^{-1} oysters
Capenhurst		0.0025 kg y^{-1} sediment 2.5 l y^{-1} water
Cardiff		28 kg y^{-1} flounders 2.9 kg y^{-1} mussels 650 h y^{-1} over mud

Table 3.2 continued

Site	Group[a]	Rates
Channel Islands		110 kg y^{-1} fish
		7 kg y^{-1} crustaceans
		18 kg y^{-1} molluscs
Chapelcross	A	8.7 kg y^{-1} flounders
		11 kg y^{-1} salmonids
		7.3 kg y^{-1} shrimps
		0.45 kg y^{-1} mussels
		1000 h y^{-1} over mud and sand
	B	1200 h y^{-1} over salt marsh
	C	250 h y^{-1} handling nets
Chatham		3000 h y^{-1} over mud
Devonport		14 kg y^{-1} salmonids
		13 kg y^{-1} fish
		5 kg y^{-1} crustaceans
		2000 h y^{-1} over mud
Dounreay	A	630 h y^{-1} handling nets
	B	54 kg y^{-1} cod
		20 kg y^{-1} crab and lobster
		0.42 kg y^{-1} winkles
	C	5.5 kg y^{-1} winkles
		380 h y^{-1} over winkle beds
	D	100 h y^{-1} in a Geo
Dungeness		98 kg y^{-1} fish
		9.4 kg y^{-1} shrimps
		14 kg y^{-1} whelks
		2000 h y^{-1} over mud
Faslane	A	500 h y^{-1} over mud
	B	38 kg y^{-1} fish
		4.8 kg y^{-1} molluscs
		670 h y^{-1} over mud and sand
Hartlepool	A	42 kg y^{-1} fish
		23 kg y^{-1} crab
		18 kg y^{-1} winkles
		3000 h y^{-1} over sand/coal
Harwell		1 kg y^{-1} pike
		650 h y^{-1} over river bank
Heysham		54 kg y^{-1} fish
		21 kg y^{-1} shrimps
		22 kg y^{-1} mussels and cockles
		900 h y^{-1} over mussel beds
Hinkley Point	A	48 kg y^{-1} flounder
		6.5 kg y^{-1} shrimps
		780 h y^{-1} over mud
	B	1000 h y^{-1} over mud
Holy Loch		900 h y^{-1} over mud
Hunterston		82 kg y^{-1} fish
		41 kg y^{-1} Nephrops
		21 kg y^{-1} scallops
		860 h y^{-1} over sand and mud
Rosyth	A	2.7 kg y^{-1} crab
	B	1900 h y^{-1} over mud and sand

Table 3.2 continued

Site	Group[a]	Rates
Sellafield	A	26 kg y^{-1} plaice and cod
		8.6 kg y^{-1} crab (75%) and lobster (25%)
		12 kg y^{-1} winkles and other molluscs
	B	2500 h y^{-1} handling nets
	C (Whitehaven boat dwelling)	270 h y^{-1} over mud
		35 kg y^{-1} cod and plaice
	D (anglers)	300 h y^{-1} over sediment (Whitehaven outer harbour)
		300 h y^{-1} over sediment (Whitehaven inner harbour)
		1100 h y^{-1} over sand (Sellafield coastal area)
		28 kg y^{-1} cod and plaice
	E (Whitehaven commercial)	57 kg y^{-1} plaice and cod
		21 kg y^{-1} Nephrops
		1 kg y^{-1} whelks
	F (Morecambe Bay)	See Heysham
	G (Fleetwood)	93 kg y^{-1} plaice and cod
		29 kg y^{-1} shrimps
		23 kg y^{-1} whelks
	H (Dumfries and Galloway)	38 kg y^{-1} plaice, cod and salmon
		13 kg y^{-1} crabs and Nephrops
		6.6 kg y^{-1} cockles and winkles
		1000 h y^{-1} over winkle beds
	I (Laverbread)	47 kg y^{-1} laverbread
	J (Trout)	6.8 kg y^{-1} rainbow trout
Sizewell		56 kg y^{-1} fish
		6.6 kg y^{-1} crustaceans
		3.8 kg y^{-1} molluscs
		260 h y^{-1} over mud
Springfields	A	2600 h y^{-1} over mud
	B	280 h y^{-1} handling nets
	C	300 h y^{-1} wildfowling
	D	700 h y^{-1} angling
Torness	A	58 kg y^{-1} fish
		11 kg y^{-1} crab and lobster
		10 kg y^{-1} Nephrops
		2.2 kg y^{-1} molluscs
	B	430 h y^{-1} over sand
	C	640y^{-1} over winkle beds
Trawsfynydd		1.8 kg y^{-1} Brown trout
		22 kg y^{-1} rainbow trout
		0.93 kg y^{-1} perch
		1000 h y^{-1} over lake shore
Upland lake		37 kg y^{-1} fish
Whitehaven		50 kg y^{-1} fish
		10 kg y^{-1} crabs and lobsters
		1.6 kg y^{-1} winkles
Winfrith	A	77 kg y^{-1} cod
		26 kg y^{-1} crab
		39 kg y^{-1} whelks
	B	390 h y^{-1} over mud
Wylfa		94 kg y^{-1} fish
		23 kg y^{-1} crab
		1.8 kg y^{-1} molluscs
		370 h y^{-1} over sand

[a] *Where more than one group exists at a site the groups are denoted A, B, etc.*

APPENDIX 4. Dosimetric data

Radionuclide	Half Life (years) disintegration)	Mean β energy (MeV per disintegration)	Mean γ energy (MeV per Adults	Dose per unit intake by ingestion using ICRP-60 methodology (Sv Bq^{-1})		
				10 yr	1 yr	H
3	1.24E+01	5.683E-03	0.000E+00	1.80E-11	2.30E-11	4.80E-11
OT3 (f)	3.39E-02	5.683E-03	0.000E+00	4.20E-11	5.70E-11	1.20E-10
C 14	5.73E+03	4.945E-02	0.000E+00	5.80E-10	8.00E-10	1.60E-09
P 32	3.91E-02	6.950E-01	0.000E+00	2.60E-09	6.00E-09	1.80E-08
S 35	2.39E-01	4.884E-02	0.000E+00	7.80E-10	1.60E-09	5.30E-09
CA45	4.46E-01	7.720E-02	0.000E+00	8.90E-10	2.00E-09	6.00E-09
MN54	8.56E-01	4.220E-03	8.364E-01	7.30E-10	1.30E-09	2.80E-09
FE55	2.70E+00	4.201E-03	1.691E-03	3.30E-10	1.10E-09	2.40E-09
CO57	7.42E-01	1.860E-02	1.250E-01	2.10E-10	5.80E-10	1.60E-09
CO58	1.94E-01	3.413E-02	9.976E-01	7.50E-10	1.70E-09	4.50E-09
CO60	5.27E+00	9.656E-02	2.500E+00	3.40E-09	1.10E-08	2.70E-08
ZN65	6.67E-01	6.870E-03	5.845E-01	3.90E-09	6.40E-09	1.60E-08
SE75	3.28E-01	1.452E-02	3.946E-01	2.60E-09	6.10E-09	1.30E-08
SR90 †	2.91E+01	1.131E+00	3.163E-03	3.22E-08	6.99E-08	1.02E-07
ZR95 †	1.75E-01	1.605E-01	1.505E+00	1.55E-09	3.09E-09	8.88E-09
NB95	9.62E-02	4.444E-02	7.660E-01	5.90E-10	1.20E-09	3.20E-09
TC99	2.13E+05	1.010E-01	0.000E+00	6.40E-10	1.30E-09	4.80E-09
RU103 †	1.07E-01	7.478E-02	4.685E-01	7.30E-10	1.50E-09	4.60E-09
RU106 †	1.01E+00	1.422E+00	2.049E-01	7.00E-09	1.50E-08	5.00E-08
AG110M †	6.84E-01	8.699E-02	2.740E+00	2.80E-09	5.20E-09	1.40E-08
SB125	2.77E+00	1.007E-01	4.312E-01	1.10E-09	2.10E-09	6.10E-09
I 125	1.65E-01	1.940E-02	4.205E-02	1.50E-08	3.20E-08	5.80E-08
I 129	1.57E+07	6.383E-02	2.463E-02	1.10E-07	1.90E-07	2.20E-07
I 131 †	2.20E-02	1.935E-01	3.813E-01	2.20E-08	5.20E-08	1.80E-07
CS134	2.06E+00	1.634E-01	1.550E+00	1.90E-08	1.40E-08	1.60E-08
CS137 †	3.00E+01	2.486E-01	5.651E-01	1.40E-08	1.00E-08	1.20E-08
BA140 †	3.49E-02	8.493E-01	2.502E+00	5.40E-09	1.19E-08	3.50E-08
CE144 †	7.78E-01	1.278E+00	5.282E-02	5.20E-09	1.10E-08	3.90E-08
PM147	2.62E+00	6.200E-02	4.374E-06	4.40E-10	1.00E-09	3.10E-09
EU154	8.80E+00	2.923E-01	1.237E+00	3.10E-09	6.50E-09	1.80E-08
EU155	4.96E+00	6.340E-02	6.062E-02	5.30E-10	1.20E-09	3.40E-09
PB210 †	2.23E+01	4.279E-01	4.810E-03	7.02E-07	1.90E-06	3.61E-06
BI210	1.37E-02	3.890E-01	0.000E+00	2.10E-09	4.80E-09	1.40E-08
PO210 (c)	3.79E-01	0.000E+00	0.000E+00	1.20E-06	2.60E-06	8.80E-06
PO210 (d)	3.79E-01	0.000E+00	0.000E+00	1.92E-06	4.16E-06	1.41E-05
RA226 †	1.60E+03	9.559E-01	1.765E+00	2.80E-07	8.10E-07	9.70E-07
TH228 †	1.91E+00	9.130E-01	1.567E+00	1.47E-07	4.28E-07	1.11E-06
TH230	7.70E+04	1.462E-02	1.553E-03	2.10E-07	2.50E-07	4.10E-07
TH232	1.41E+10	1.251E-02	1.332E-03	2.30E-07	2.90E-07	4.50E-07
U 234	2.44E+05	1.320E-02	1.733E-03	5.00E-08	7.40E-08	1.30E-07
U 235 †	7.04E+08	2.147E-01	1.815E-01	4.70E-08	7.10E-08	1.30E-07
U 238 †	4.47E+09	8.915E-01	2.235E-02	4.84E-08	7.55E-08	1.45E-07
NP237 †	2.14E+06	2.668E-01	2.382E-01	1.10E-07	1.20E-07	2.10E-07
PU238 (a)	8.77E+01	1.061E-02	1.812E-03	2.30E-07	2.50E-07	4.00E-07
PU238 (b)				9.20E-08	1.00E-07	1.60E-07
PU239 (a)	2.41E+04	6.738E-03	8.065E-04	2.50E-07	2.70E-07	4.20E-07
PU239 (b)				1.00E-07	1.08E-07	1.68E-07
PU α (e)	2.41E+04	6.738E-03	8.065E-04	2.50E-07	2.70E-07	4.20E-07
PU240 (a)	6.54E+03	1.061E-02	1.731E-03	2.50E-07	2.70E-07	4.20E-07
PU240 (b)				1.00E-07	1.08E-07	1.68E-07
PU241 (a)	1.44E+01	5.246E-03	2.546E-06	4.80E-09	5.10E-09	5.80E-09
PU241 (b)				1.92E-09	2.04E-09	2.32E-09
AM241 (a)	4.32E+02	5.207E-02	3.253E-02	2.10E-07	2.20E-07	3.80E-07
AM241 (b)				8.40E-08	8.80E-08	1.52E-07
CM242	4.46E-01	9.594E-03	1.832E-03	1.60E-08	3.50E-08	1.00E-07
CM243	2.85E+01	1.384E-01	1.347E-01	2.00E-07	2.60E-07	5.40E-07
CM244	1.81E+01	8.590E-03	1.700E-03	1.70E-07	2.10E-07	4.70E-07

† *Energy and dose per unit intake data include the effects of radiations of short-lived daughter products*
(a) Gut transfer factor 5.00E-4 for consumption of all foodstuffs except Cumbrian winkles
(b) Gut transfer factor 2.00E-4 for consumption of Cumbrian winkles
(c) Gut transfer factor 0.5
(d) Gut transfer factor 0.8
(e) PU239 data used
(f) Organically bound tritium

APPENDIX 5. Estimates of concentrations of radionuclides due to natural sources

5.1 Aquatic foodstuffs

Table 5.1 gives estimated values of concentrations of radionuclides due to natural sources in aquatic foodstuffs. The values are based on sampling and analysis carried out by MAFF. Dose assessments for aquatic foodstuffs are based on activity concentrations of these radionuclides net of natural background. Similarly, natural levels of carbon-14 are subtracted when assessing exposures due to man-made sources of this radionuclide. The natural concentrations of carbon-14 are determined by measuring the carbon concentration in each sample and applying a specific activity of 254 Bq ^{14}C natural/kg C (Collins, *et al*., 1995).

5.2 Terrestrial foodstuffs

The values of carbon-14 in terrestrial foodstuffs due to natural sources that are used in dose assessments are given in Table 5.2 (MAFF, 1995).

Table 5.1 Radioactivity in seafood due to natural sources

Radionuclide	Concentration of radioactivity Bq kg^{-1} (wet)						
	Fish	Crustaceans	Crabs	Lobsters	Molluscs	Winkles	Mussels
Lead-210	0.025		0.3	0.08		0.69	1.1
Polonium-210	0.28		8.5	4.6		7.1	25.6
Radium-226	0	0.03			0.08		
Thorium-228	0.0054		0.04	0.0096	0.089		
Thorium-230	0.00081		0.008	0.0026	0.038		
Thorium-232	0.00097		0.01	0.0014	0.063		
Uranium-234	0.0045		0.0547	0.0403	0.714		
Uranium-238	0.0039		0.0458	0.0351	0.621		

Table 5.2 Carbon-14 in terrestrial foodstuffs due to natural sources

Food Category	% Carbon content (wet)	Concentration of carbon-14 (Bq/kg (wet))
Milk	7	18
Bovine meat	17	44
Ovine meat	21	54
Pork	21	54
Poultry	28	72
Game	15	38
Offal	12	31
Eggs	15	38
Green vegetables	3	8
Root vegetables	3	8
Legumes/other domestic vegetables	8	20
Dry beans	20	51
Potato	9	23
Cereals	41	105
Cultivated fruit	4	10
Wild fruit	4	10
Mushrooms	2	5
Honey	31	79
Nuts	58	148

APPENDIX 6. Modelling of activity in milk and livestock

At Sellafield, Drigg, Ravenglass and the Isle of Man, a simple foodchain model has been used to provide concentrations of activity in milk and livestock for selected radionuclides to supplement data obtained by direct measurement. This is done where relatively high limits of detection are determined or where no measurements were made. The foodchain model is applied to grass or soil concentrations which are determined by measurement. The data for the model are given in Table 6.1 (Simmonds *et al*., 1995 and Brenk *et al*., unpublished) and the predicted concentrations used in the assessment are in Table 6.2.

The activity in the milk is given by the equation:

$$C = F_m \, Ca \, Q_f \exp(-\lambda t)$$

Similarly the activity in muscle or offal is

$$C = F_f \, Ca \, Q_f \exp(-\lambda t)$$

Table 6.1 Data for foodchain model

Parameter	Nuclide	Foodstuff				
		Milk	Beef	Beef offal	Lamb	Sheep offal
Q_f		13	13	13	1.5	1.5
Q_s		4	4	4	20	20
t_f		4	-	-	-	-
t_s		-	20	20	20	20
F_m or F_f	^{99}Tc	1.00E-02	1.00E-02	4.00E-02	1.00E-01	4.00E-01
	^{106}Ru	1.00E-06	1.00E-03	1.00E-02	1.00E-02	1.00E-02
	^{144}Ce	2.00E-05	1.00E-03	2.00E-01	1.00E-02	2.00E+00
	^{147}Pm	2.00E-05	5.00E-03	4.00E-02	5.00E-02	3.00E-01
	^{241}Pu	1.00E-06	1.00E-04	4.00E-04	2.00E-02	3.00E-02

where: Q_f = *the amount of pasture consumed per day (kg d^{-1} (dry))*
Q_s = *soil consumption as a percentage of dry matter intake (%(dry))*
t_f = *time taken from point of milk production to point of consumption (d)*
t_s = *time from slaughter to consumption (d)*
F_m = *the fraction of daily intake by ingestion transferred to a litre of milk (d l^{-1})*
F_f = *the fraction of daily intake by ingestion transferred to a kg of muscle or liver (d kg^{-1})*
Ca = *The concentration of the nuclide in the fodder consumed by the animal (Bq kg^{-1})*

Table 6.2 Predicted concentrations from foodchain model used in assessments of exposures

Foodstuff	Location	Radioactivity concentration (wet weight), Bq kg^{-1}				
		^{99}Tc	^{106}Ru	^{144}Ce	^{147}Pm	^{241}Pu
Milk	Sellafield		<4.94 10^{-4}	<4.94 10^{-3}		
	Ravenglass		<6.50 10^{-5}	<2.86 10^{-3}		
	Drigg		<4.68 10^{-4}	<3.25 10^{-3}	<7.28 10^{-3}	
	Isle of Man		4.0 10^{-4}	6.0 10^{-3}		
Beef	Sellafield	<0.065*	<0.494	<0.247		
	Ravenglass		<6.50 10^{-3}	<0.143		
	Drigg	<0.065*	<0.468	<0.163*	<1.82	<1.30 10^{-3}
Lamb	Sellafield	<0.03*	<0.057	<5.7		
	Ravenglass		<7.50 10^{-4}			
	Drigg	<0.33*	<0.054	<1.5*		
	Isle of Man		0.47	0.26		
Beef offal	Sellafield	<0.65*				
	Ravenglass	47.5*	<6.50 10^{-2}	<1.43		
	Drigg	<0.65*	<4.68	<1.63*	<18.2	<0.26
Lamb offal	Sellafield	<0.3*	<0.57			
	Ravenglass	20.3*	<7.50 10^{-3}			
	Drigg	<3.3*	<0.54			<0.03
	Isle of Man		0.47			

*Concentrations were modelled using the activity in Leafy Green Vegetables except for those marked * where the values in grass were used*

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