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Monitoring of Radiation in the Environment Results in the Netherlands in 1998

J.E.M. Jacobs[1], Editor

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CONTENTS

ABSTRACT

This report presents the results of radioactivity measurements in the environment in the Netherlands carried out by RIZA, RIKZ, Inspectorate for Health Protection, Commodities and Veterinary Public Health and RIVM in 1998. The yearly averaged gross α- and gross β-activity concentrations in air dust in Bilthoven were 0.0812 and 0.398 $mBq \cdot m^{-3}$, respectively. The yearly averaged activity concentrations in air dust for the nuclides ^{7}Be, ^{137}Cs and ^{210}Pb were 4020, 1.26 and 325 $\mu Bq \cdot m^{-3}$, respectively. The yearly total gross α- and gross β-activities deposited in Bilthoven were 31.1 and 106 $Bq \cdot m^{-2}$, respectively. The yearly total activities of the nuclides ^{3}H, ^{137}Cs, ^{7}Be, ^{210}Pb and ^{210}Po in deposition were 1200, 0.60, 1840, 163 and < 16 $Bq \cdot m^{-2}$, respectively. The ambient dose equivalent rate averaged across the country over the year was 75.2 $nSv \cdot h^{-1}$, with163 measurement locations. The yearly averaged activity concentration in surface water for ^{3}H was between 5 and 10.5 $Bq \cdot L^{-1}$ and for residual β between 39 and 82 $mBq \cdot L^{-1}$ (three measurement locations). The yearly averaged activity of ^{137}Cs in suspended solids in surface water was between 15 and 27 $Bq \cdot kg^{-1}$ (four measurement locations). In sea water yearly averages for ^{3}H varied between 0.6 and 4.9 $Bq \cdot L^{-1}$ and for residual β between 43 and 45 $mBq \cdot L^{-1}$ (three measurement locations).
Typical activities found in drinking water were 1-10 $Bq \cdot L^{-1}$ for ^{3}H activity and 0.1-1 $Bq \cdot L^{-1}$ for gross β and residual β activity. All these values are comparable to those of previous years.
Since no measurements were performed in milk in 1998, data for 1997 are reported.
Food was measured when suspected of having an abnormal level of radioactivity. Only in one sample of mushrooms, from Lithuania, was an activity above the limit of 600 $Bq \cdot kg^{-1}$ (limit for the sum of ^{134}Cs and ^{137}Cs from the Chernobyl accident) found.

Comparison between the Dutch monitoring programme and the recommendation of the Commission of the European Communities on the application of Article 36 of the Euratom Treaty shows that the Dutch programme is not in full compliance with the recommendation.

SAMENVATTING

Dit rapport geeft de resultaten van radioactiviteitsmetingen in het milieu in Nederland verricht door RIZA, RIKZ, Keuringsdienst van Waren en RIVM in 1998. De jaargemiddelde totale α- en β-activiteitsconcentratie in luchtstof in Bilthoven was 0,0812 en 0,398 $mBq \cdot m^{-3}$. De jaargemiddelde activiteitsconcentratie in luchstof van de nucliden ^{7}Be, ^{137}Cs en ^{210}Pb was respectievelijk 4020 1,26 en 325 $\mu Bq \cdot m^{-3}$.
De jaarlijkse totale α- en β-activiteit in depositie in Bilthoven bedroeg 31,1 en 106 $Bq \cdot m^{-2}$. De jaarlijkse totale activiteit van de nucliden ^{3}H, ^{137}Cs, ^{7}Be, ^{210}Pb en ^{210}Po in depositie bedroeg respectievelijk 1200, 0,60, 1840, 163 en < 16 $Bq \cdot m^{-2}$.
Het omgevingsdosisequivalenttempo, gemiddeld over het jaar en over Nederland, was 75,2 $nSv \cdot h^{-1}$, met163 meetlokaties.
De jaargemiddelde activiteitsconcentratie in oppervlaktwater van ^{3}H lag tussen 5 en 10,5 $Bq \cdot L^{-1}$ en van rest β tussen 39 en 82 $mBq \cdot L^{-1}$ (3 meetlocaties). De jaargemiddelde activiteit van ^{137}Cs in zwevend stof in oppervlaktewater lag tussen 15 en 27 $Bq \cdot kg^{-1}$ (4 meetlokaties). De jaargemiddelde activiteitsconcentratie in zeewater van ^{3}H lag tussen 0,6 en 4,9 $Bq \cdot L^{-1}$ en van rest β tussen 43 en 45 $mBq \cdot L^{-1}$ (3 meetlokaties).
Typische waarden die in drinkwater gevonden worden zijn 1-10 $Bq \cdot L^{-1}$ voor ^{3}H-activiteit en 0,1-1 $Bq \cdot L^{-1}$ voor totaal β- en rest β-activiteit. Al deze waarden zijn vergelijkbaar met de waarden in voorgaande jaren.
Omdat er in 1998 geen metingen zijn verricht aan melk, zijn resultaten uit 1997 vermeld.
Voedsel werd gemeten als het vermoeden bestond dat het een abnormale hoeveelheid radioactiviteit bevatte. Er werd in slechts één monster paddestoelen uit Litouwen een activiteit van meer dan de norm van 600 $Bq \cdot kg^{-1}$ (norm voor de som van ^{134}Cs en ^{137}Cs afkomstig van het ongeluk in Chernobyl) gevonden.

Uit de vergelijking van het Nederlandse meetprogramma met de “recommendation of the Commission of the European Communities on the application of article 36 of the Euratom Treaty” blijkt dat het Nederlandse meetprogramma hiermee niet in volledige overeenstemming is.

1. INTRODUCTION

Levels of radioactive nuclides of natural origin, such as ^{40}K and daughters from the uranium and thorium series may be enhanced as a result of human activities, e.g. emissions from factories processing ores. Man-made radionuclides are found in the environment due to, for example, nuclear weapons tests or discharges from nuclear installations.

Until 1994, measurements on radioactivity in the Netherlands' environment were coordinated by the Coordinating Committee for Measurements in the Environment, CCRX [1]. Measurements were subdivided into those for the National Measurement Programme (NMP-CCRX) [1] and additional measurements. NMP-CCRX included the monitoring of air dust, deposition, surface water, milk and fish products. Milk and grass samples taken from the surroundings of nuclear reactors were also analysed. Additional measurements comprised monitoring of specific radionuclides in the environment. Results, reported annually, were also submitted to the EU in the framework of Article 35/36 of the Euratom Treaty.

In the years after 1994 most institutes working within the NMP-CCRX continued their monitoring programmes, either on a complete or partial basis. However, the results were no longer collated. Data on air dust, surface water and milk are still sent to the EU and reported annually by the EU [2].

In 1998 and 1999 the EU drafted the 'Recommendation of the Commission of the European Communities on the Application of Article 36 of the Euratom Treaty' (see Appendix A). The recommendation describes the programme of measurements on radioactivity in the environment that should be implemented by the Member States. According to the recommendation, results have to be reported annually. The EU only reports the results. Interpretation of the results and information on measuring methods and sampling should be supplied by the Member States in separate reports.

The aim of this report is threefold. Firstly, it represents the first attempt since the discontinuation of the CCRX to present an almost complete survey of measurements on radioactivity in the Netherlands' environment under normal circumstances. Secondly, it is aimed at determining if monitoring programmes in the Netherlands are in compliance with the (draft) EU recommendation and at assessing omissions. Thirdly, the report can function as a pilot for the Dutch national report to the EU and to other Member States.

The following institutes have contributed to this report:

- The Institute for Inland Water Management and Waste Water Treatment (RIZA), providing data on surface water from the main inland waters.
- The National Institute for Coastal and Marine Management (RIKZ), providing data on marine water, with data submitted by RIZA.
- The Inspectorate for Health Protection, Commodities and Veterinary Public Health, providing measurements on foodstuffs.
- The National Institute of Public Health and the Environment (RIVM), providing data on air dust, deposition, milk and ambient dose rates.

- Information on drinking water was obtained from the Laboratory for Water and Drinking Water Research of RIVM. Measurements were performed by or under the auspices of the companies responsible for drinking water in the Netherlands.

Chapters 2 to 8 have been subdivided according to the structure of the Recommendation of the Commission of the European Communities on the Application of Article 36 of the Euratom Treaty and give the results of measurements for certain compartments of the environment. Chapter 9 deals with the compliance of the Dutch monitoring programme with the requirements of the Recommendation and assesses its shortcomings. Chapter 10 presents general conclusions.

2. AIRBORNE PARTICULATES

The monitoring programme in 1998 for determining radioactive nuclides in airdust is given in *Table 2.1*. The sampling was done on the RIVM premises in Bilthoven. Airdust samples for the measurement of γ-emitters, gross α and gross β were collected weekly with a High Volume Sampler (HVS). A detailed description of sampling, sample treatment and analytical method is given in previous reports [4,5,21].

Table 2.1: Monitoring programme in 1998 for the determination of radioactive nuclides in air dust.

Measurement	Location	Sample Period	Sample Volume	Analysis frequency	Analysis
Air dust	Bilthoven	Week	± 50000 m^3	1 per week	γ-em**
	Bilthoven	Week	± 1000 m^3 *	1 per week	gross α, gross β

** γ-em: γ-spectroscopic analysis in which the contents of specific γ-emitting nuclides are determined
*: A subsample of 2% is taken from the filter through which 50000 m^3 is sampled

2.1 GROSS α/β-ACTIVITY

The weekly results of gross α- and β-activity concentrations in airdust are given in *Figure 2.1* and *Table B1* (see Appendix B). The period between sampling and analysis is 5 to 10 days, which is long compared to the decay time of the short-lived decay products of ^{222}Rn and ^{220}Rn. For this reason, these naturally occurring decay-products do not contribute to the α- and β-activity concentrations. Sampling by HVS has started in 1992.

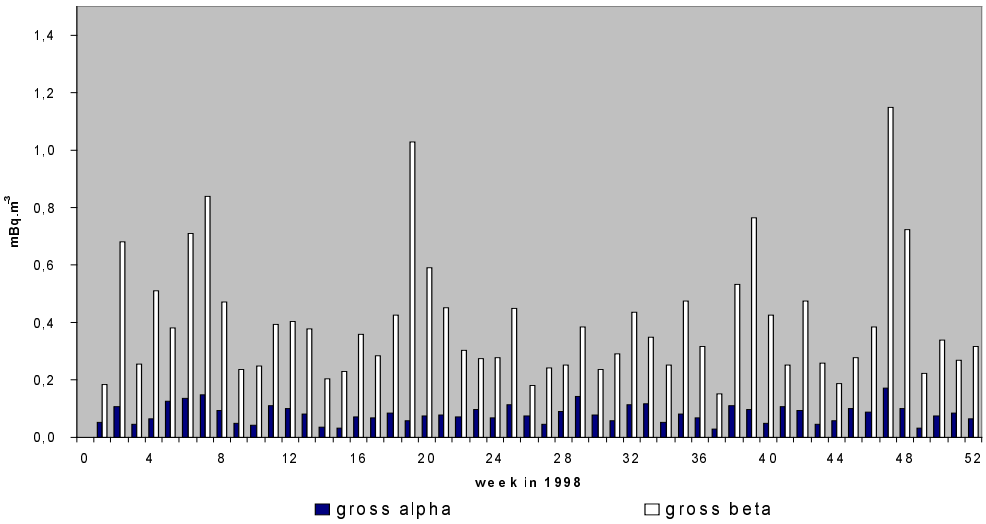

Figure 2.1: Weekly results in 1998 of gross α- and gross β-activity concentrations of long-lived nuclides in air dust sampled at the RIVM in Bilthoven (The Netherlands).

The frequency distributions of gross α-activity and gross β-activity concentrations in air dust are given in *Figures 2.2* and *2.3*, respectively. SD is the standard deviation and illustrates the variation in weekly averages during the year.

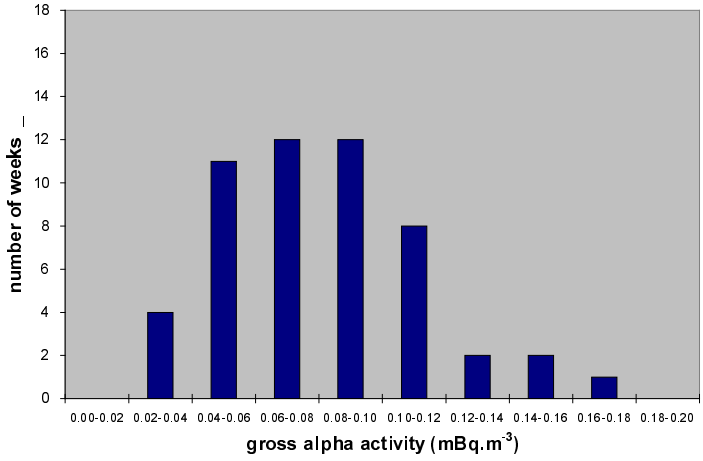

Figure 2.2: Frequency distribution of gross α-activity concentration of long-lived nuclides in air dust collected weekly at the RIVM, Bilthoven (The Netherlands) in 1998. Mean concentration is 0.0812 ± 0.0012 (SD=0.03) mBq·m^{-3}.

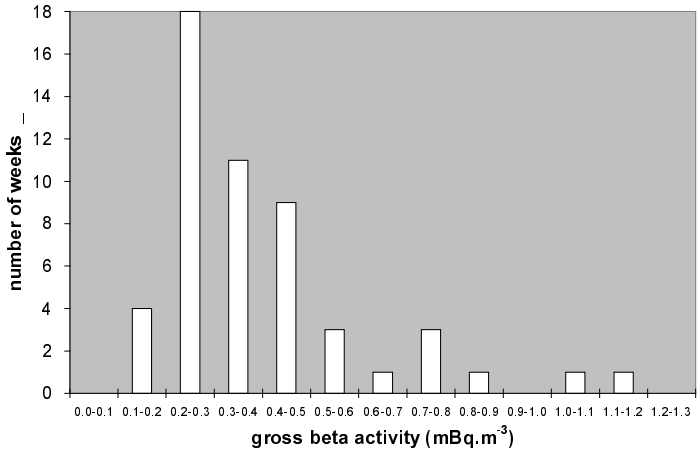

Figure 2.3: Frequency distribution of gross β-activity concentration of long-lived nuclides in airdust collected weekly at the RIVM, Bilthoven (The Netherlands) in 1998. Mean concentration is 0.398 ± 0.004 (SD=0.2) mBq·m^{-3}.

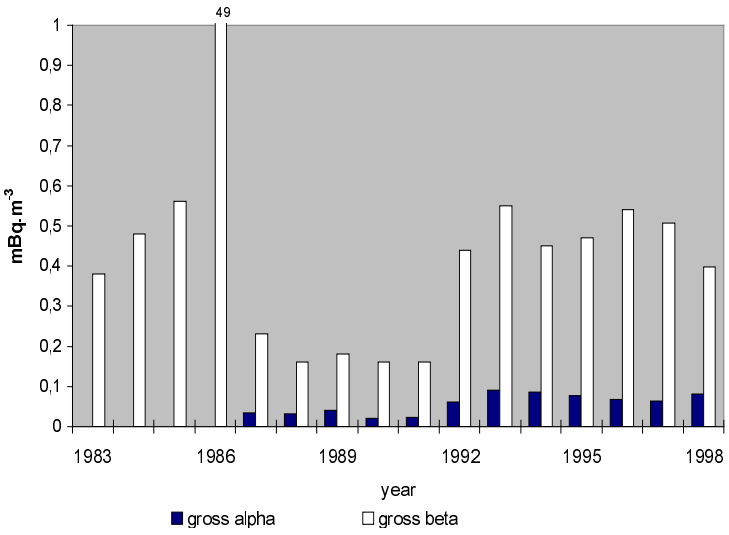

Figure 2.4: Yearly averages of gross α- and gross β-activity concentration of long-lived nuclides in airdust from the outset of the respective monitoring campaigns. The '86 level was caused by the accident at the Chernobyl nuclear power plant.

The yearly averages of the gross α- and β-activity concentrations of long-lived nuclides in 1998 amount to the same as the results in the period 1992-1997 [3-8] (see *Figure 2.4*).

2.2 γ-EMITTING NUCLIDES

The nuclides ^{7}Be, ^{137}Cs and ^{210}Pb are the only detectable nuclides (*Table B2*; *Figure 2.5, 2.6* and *2.7*). The detection limits for the nuclides considered in the gammaspectroscopic analysis of the HVS-samples are given in *Table B3.* The concentrations found for ^{7}Be, ^{137}Cs and ^{210}Pb in 1998 are comparable to those found in 1992-1997 [3-8].

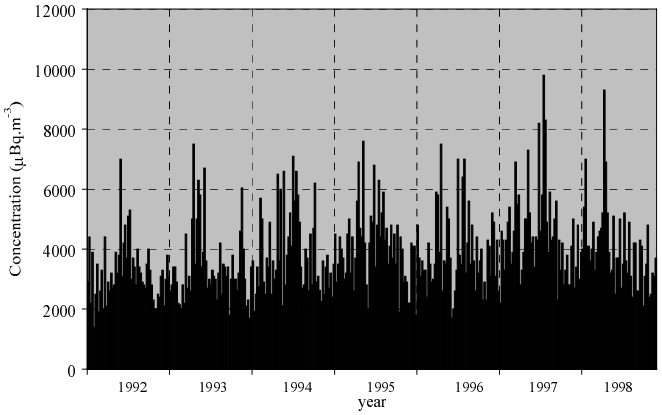

Figure 2.5: Weekly averaged activity concentrations of ^{7}Be in air dust in Bilthoven in 1992-1998. Yearly average for 1998 is 4020 ± 50 (SD=1300) μBq·m^{-3}.

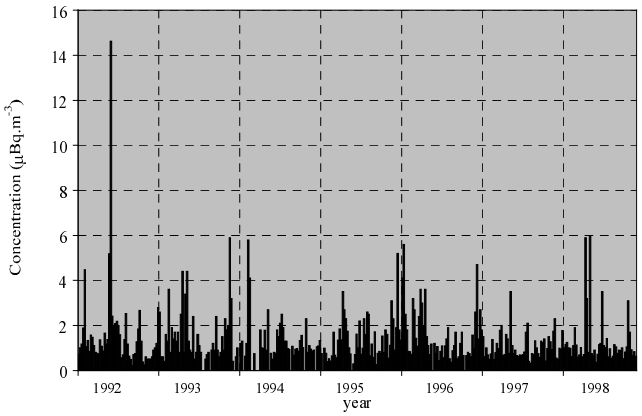

Figure 2.6: Weekly averaged activity concentrations of ^{137}Cs in air dust in Bilthoven for 1992-1998. Yearly average for 1998 is 1.26 ± 0.04 (SD=1.14) μBq·m^{-3}.

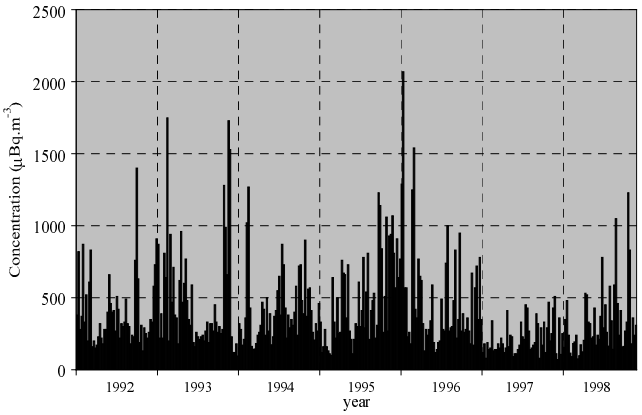

Figure 2.7: Weekly averaged activity concentrations of ^{210}Pb in air dust in Bilthoven for 1992-1998. Yearly average for 1998 is 325 ± 5 (SD=235) μBq·m^{-3}.

On 11 June 1998 messages were received from the International Atomic Energy Agency and the European Community Urgent Radiological Information Exchange reporting station in Luxembourg stating that elevated levels of ^{137}Cs have been measured in air in Central and South-East Europe at the beginning of June [9]. According to later information a ^{137}Cs source had accidentally been melted in Algeciras (Spain) at 29 May. A ^{137}Cs concentration of 6.0 ± 0.5 $\mu Bq \cdot m^{-3}$ was found in Bilthoven from 29 May to 5 June a concentration higher than found in most weeks, but occurring several times a year.

The source term was estimated by comparing model calculations with measurements done in several countries (*Figure 2.8)*. The model, called NPK-PUFF, is used by LSO for calculations in the case of nuclear accidents. Model estimates and measurements corresponded best by assuming a 10 TBq source term [9].

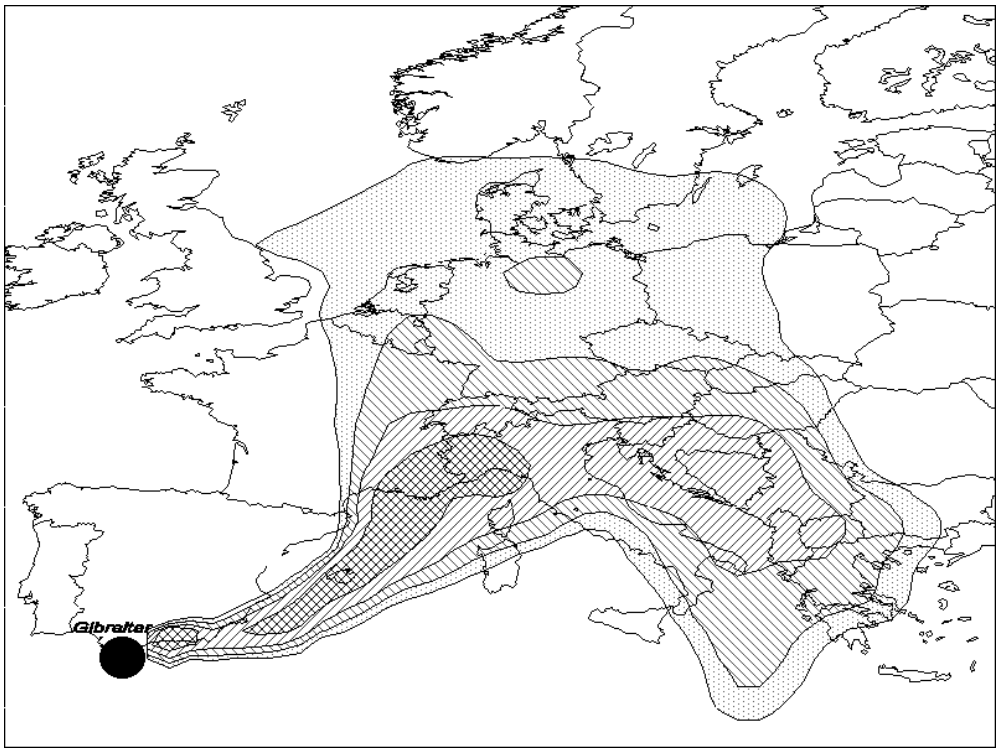

Figure 2.8: Time integrated air concentration over the period 29.05.98 12:00 UTC to 03.06.98 11:00 UTC (source 10 TBq), greater than 10^{-12} $Bq \cdot h \cdot m^{-3}$ (dots), greater than 10^{-9} $Bq \cdot h \cdot m^{-3}$ (left hatched), greater than 10^{-6} $Bq \cdot h \cdot m^{-3}$ (right hatched) and greater than 10^{-3} $Bq \cdot h \cdot m^{-3}$ (crosshatched).

3. DEPOSITION

The 1998 monitoring programme for the determination of radioactive nuclides in deposition is given in *Table 3.1*. Sampling was done on the RIVM premises in Bilthoven. Samples were collected weekly (γ-emitters) and monthly (^{3}H, gross α, gross β, ^{210}Pb/^{210}Po). For the ^{210}Pb/^{210}Po analysis, three monthly samples were combined into one sample, which was analysed quarterly.

Table 3.1: The 1998 monitoring programme for the determination of radioactive nuclides in deposition.

Measurement	Location	Sample Period	Sample Volume	Analysis frequency	Analysis
Deposition	Bilthoven	Week	Variable	Once per week	γ-em **
	Bilthoven	Month	Variable	Once per month	Gross α, gross β, ^{3}H
	Bilthoven	Month	Variable	Once per quarter	^{210}Pb/^{210}Po

** γ-em: γ-spectroscopic analysis in which the contents of specific γ-emitting nuclides are determined

3.1 GROSS α/β-ACTIVITY

The monthly deposited gross α- and gross β-activity of long-lived nuclides are given in *Figure 3.1* and in *Table B4*. The yearly total deposition of gross α and gross β was 31.1 ± 1.3 and 106 ± 3 Bq·m^{-2}, respectively, values comparable to those measured since 1987, as illustrated in *Figure 3.2* and *Table B5*.

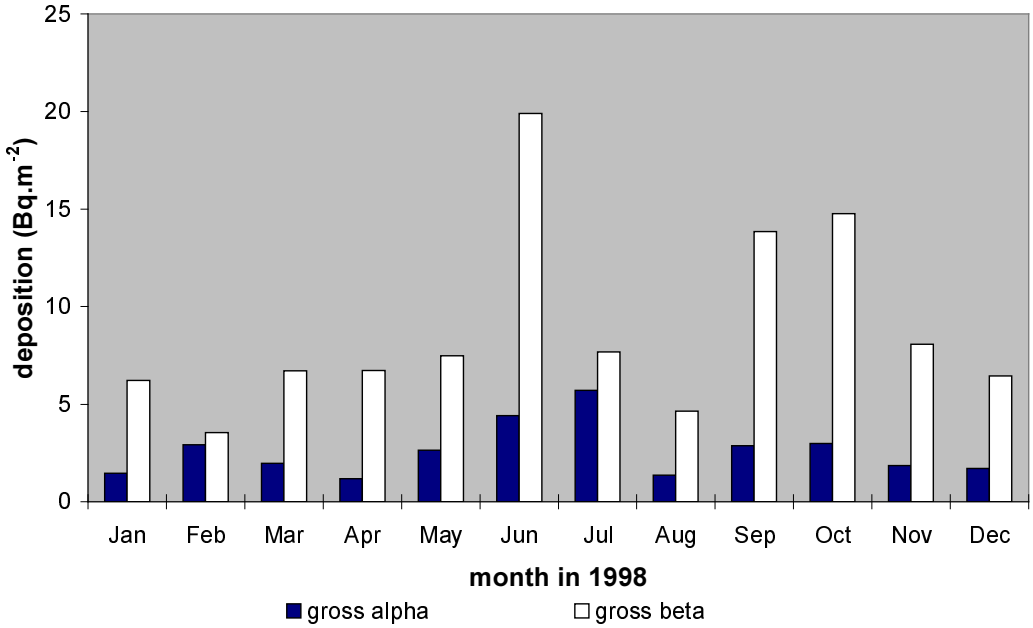

Figure 3.1: Monthly deposited gross α- and gross β-activity of long-lived nuclides in 1998.

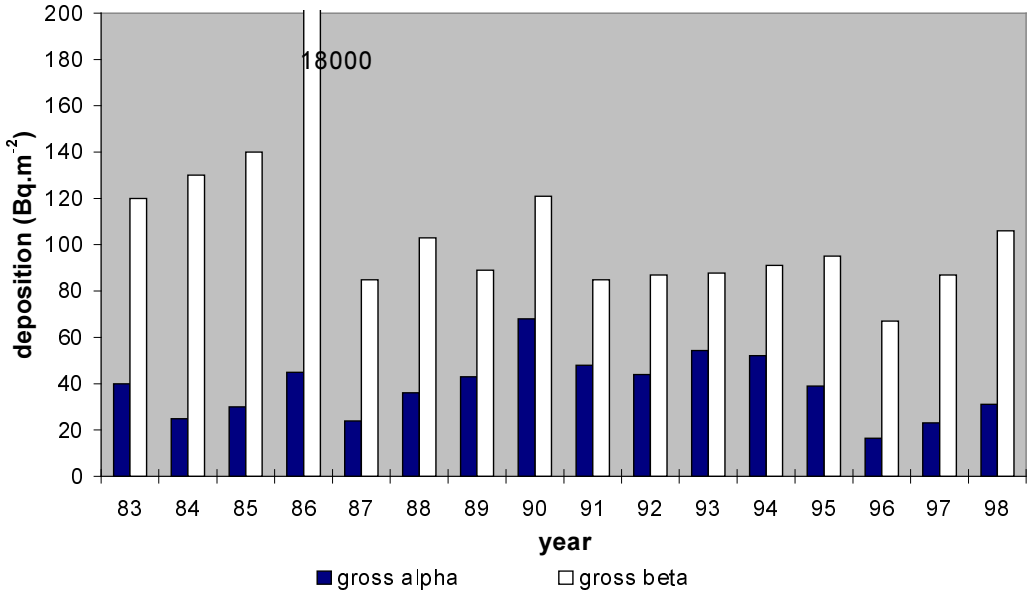

Figure 3.2: Total gross α- and gross β-activity of long-lived nuclides deposited from 1983 to 1998 (See also Table 3.1). The 1986 level resulted from the accident at the Chernobyl nuclear power plant.

The monthly depositions of ^{3}H and the weekly depositions of ^{7}Be, ^{137}Cs and ^{210}Pb are given in *Tables B4* and *B7.* In 1998 1200 ± 110 Bq·m^{-2} of ^{3}H was deposited. For the calculation of the yearly total, only months with depositions above the detection limit are used. This gives an extra uncertainty and means that the maximum yearly total could have been 2000 Bq·m^{-2}. *Figure 3.3* shows the exponential decay of ^{3}H expected after the end of the atmospheric nuclear weapons tests in the seventies.

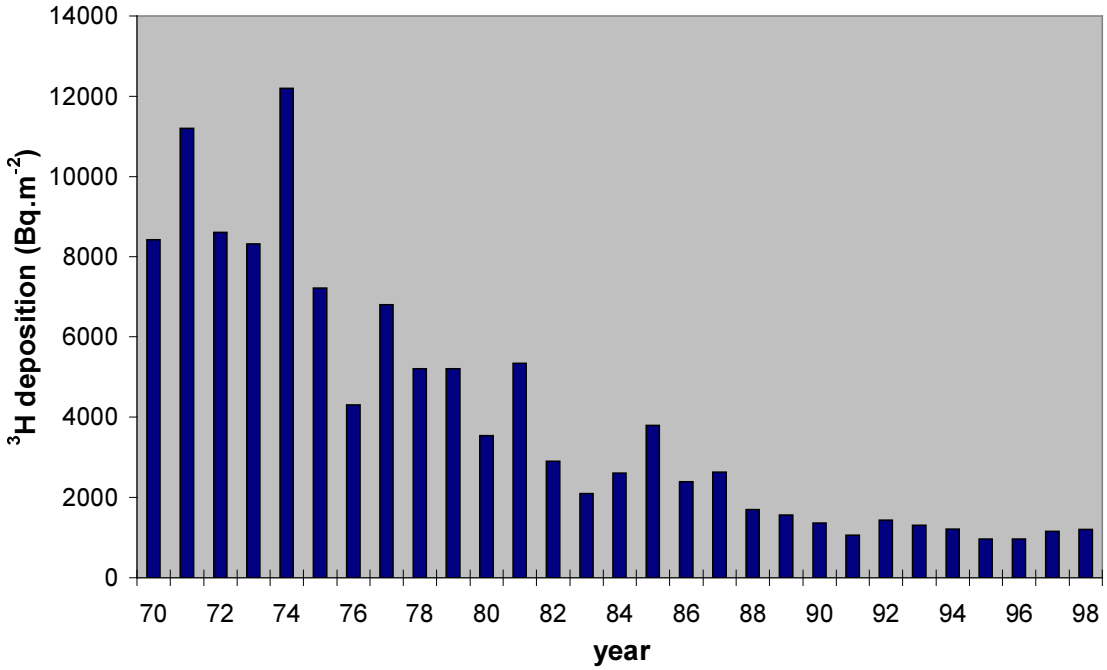

Figure 3.3: Total deposition of ^{3}H in the period 1970-1998.

3.2 γ-ACTIVITY

Detectable quantities of the naturally occurring nuclides ^{7}Be and ^{210}Pb were found, with yearly total depositions of 1840 ± 50 and 163 ± 4 Bq·m^{-2}. For ^{137}Cs weekly depositions reaching a maximum of 0.106 ± 0.016 Bq·m^{-2} (detection limit is about 0.005 Bq·m^{-2}) and a yearly total deposition of 0.60 ± 0.03 Bq·m^{-2} were found. ^{134}Cs was not found (detection limit is about 0.2 Bq·m^{-2}).

Figure 3.4 shows the relationship between the monthly deposition of ^{3}H and the amount of precipitation. *Figure 3.5* shows the same relationship for the weekly deposition of ^{7}Be and *Figure 3.6* for ^{210}Pb. *Figure 3.4* indicates a correlation between the amount of precipitation and the deposition of ^{3}H. *Figure 3.5* also indicates a correlation between the amount of precipitation and the deposition of ^{7}Be. The correlation between the amount of precipitation and the deposition of ^{210}Pb is less clear as can be seen in *Figure 3.6*.

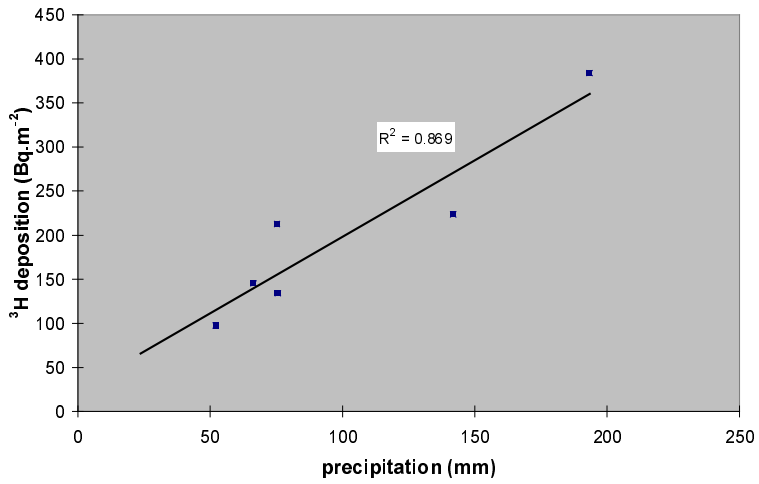

Figure 3.4: The monthly deposition of ^{3}H in 1998 versus precipitation.

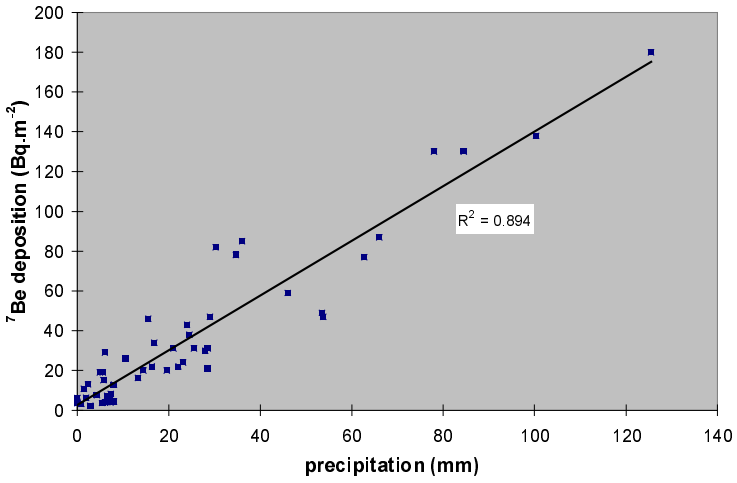

Figure 3.5: The weekly deposition of ^{7}Be in 1998 versus precipitation.

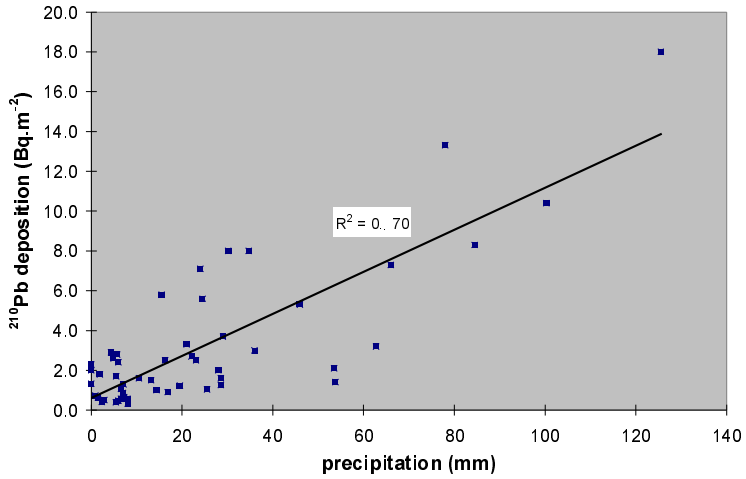

Figure 3.6: The weekly deposition of ^{210}Pb in 1998 versus precipitation.

The quarterly α-spectroscopy results for ^{210}Pb and ^{210}Po are given in *Table B6*. The results for previous years are given in *Table B5*. In 1995 a contamination of the samples occurred preventing results for ^{210}Pb en ^{210}Po being reported [20]. The gross β results are mainly thanks to ^{210}Pb.

4. NATIONAL RADIOACTIVITY MONITORING NETWORK

This chapter presents data on ambient dose equivalent rates, man-made gross β-activity concentrations and gross α-activity concentrations. The data on gross α and gross β differ in sample size, sampling frequency and analytical procedures from those given in the previous chapter.

In previous reports data from the National Radioactivity Monitoring Network, LMR (Landelijk Meetnet Radioactiviteit) were presented [5-8, 33-34]. In 1996 this monitoring network merged with another monitoring network in the Netherlands, the BMNI [22]. The result is the present monitoring network called the NMR (Nationaal Meetnet Radioactiviteit), which consisted, in 1998, of almost 300 ambient dose equivalent rate monitors and 14 aerosol monitors for determining gross α and 'man-made' gross β-activity concentrations. The High Volume Sampler is intended to determine low concentrations of radioactive nuclides in air dust. The aerosol monitors of the NMR are intended to provide an early warning against nuclear accidents and to supply information on background levels.

In 1999 the NMR was reorganised into a network consisting of 163 dose equivalent rate monitors [23]. Since 1996 the analysis of trends in the ambient dose equivalent rate is based on this set of 163 stations. The yearly averages before 1996 are calculated from data from the 58 stations of the former LMR.

The data presented in this chapter are based on averages over periods of ten minutes. From these values averages over the year are calculated (*Table B8* and *B9).* These data of external radiation, expressed in ambient dose-equivalent, contain a systematic error. For the correction of data of the LMR locations a conversion formula is presented in [34]. In *Figures 4.1* and *4.2*, the spatial variation of the yearly averages of the NMR data is constructed using RIVM's Geographical Information System (GIS). An interpolation algorithm has been applied to calculate values in between NMR stations. *Table 4.1* presents the yearly averages for 1990 to 1998.

Table 4.1: The yearly averages of gross α-activity concentration and ambient dose equivalent rate [4-8, 10 and 11], values for 1996 and 1997 not being previously reported.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Gross α $Bq \cdot m^{-3}$	2.4	3.3	2.4	2.6	2.4	3.7	3.5	3.5	3.0
Ambient dose rate $nSv \cdot h^{-1}$	80	78.9	79.3	77.3	78	80.2	76.4	76.0	75.2

The 1998 yearly average, of the gross α activity concentration for all sites with an aerosol monitor, is comparable to previous years. For the ambient dose equivalent rate the average over the year and across the country in 1998 is also comparable to previous years.

The yearly averages of the 'man-made' gross β-activity concentration do not deviate significantly from zero.

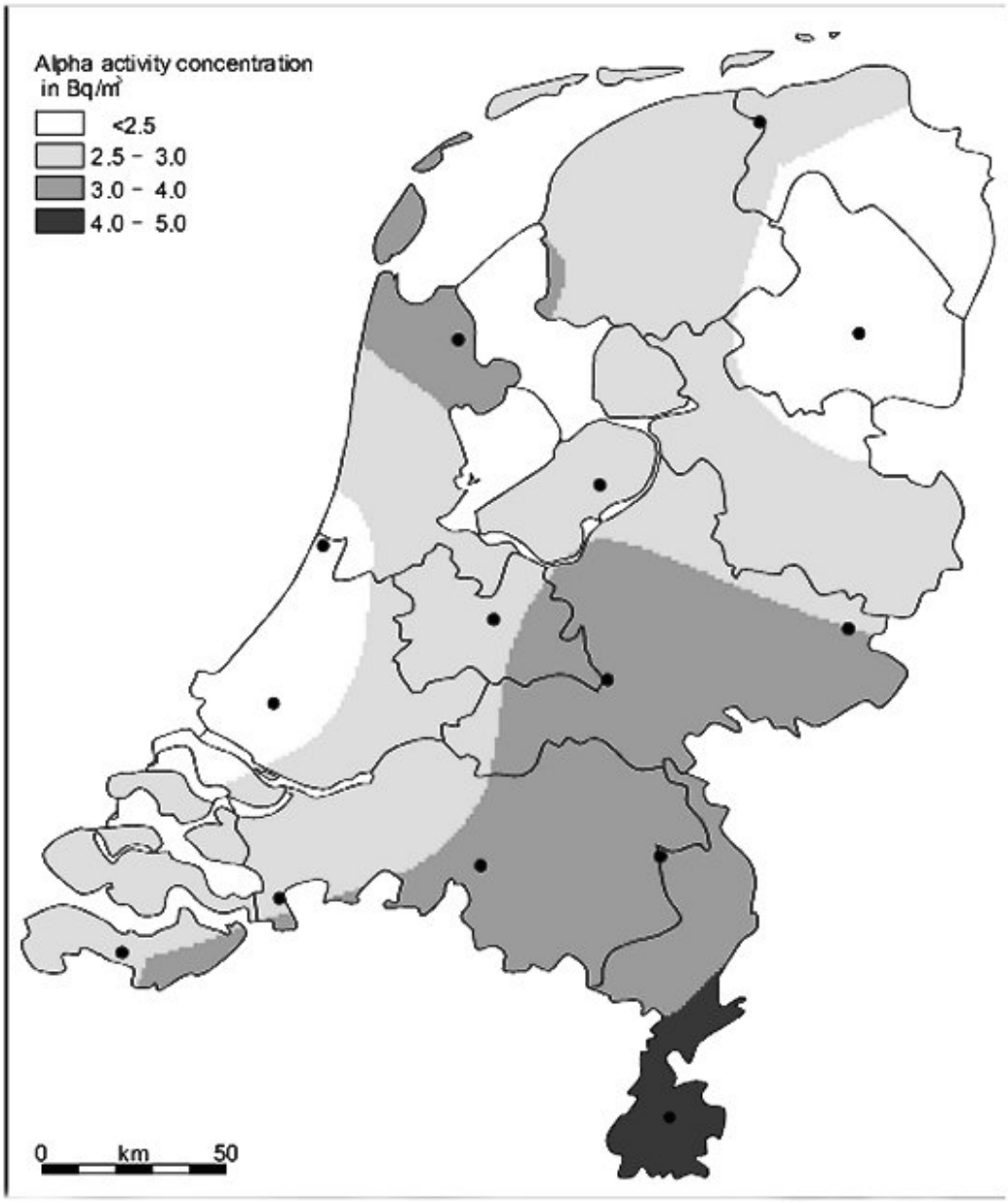

Figure 4.1: The gross α-activity concentration in $Bq \cdot m^{-3}$ in air averaged over 1998.

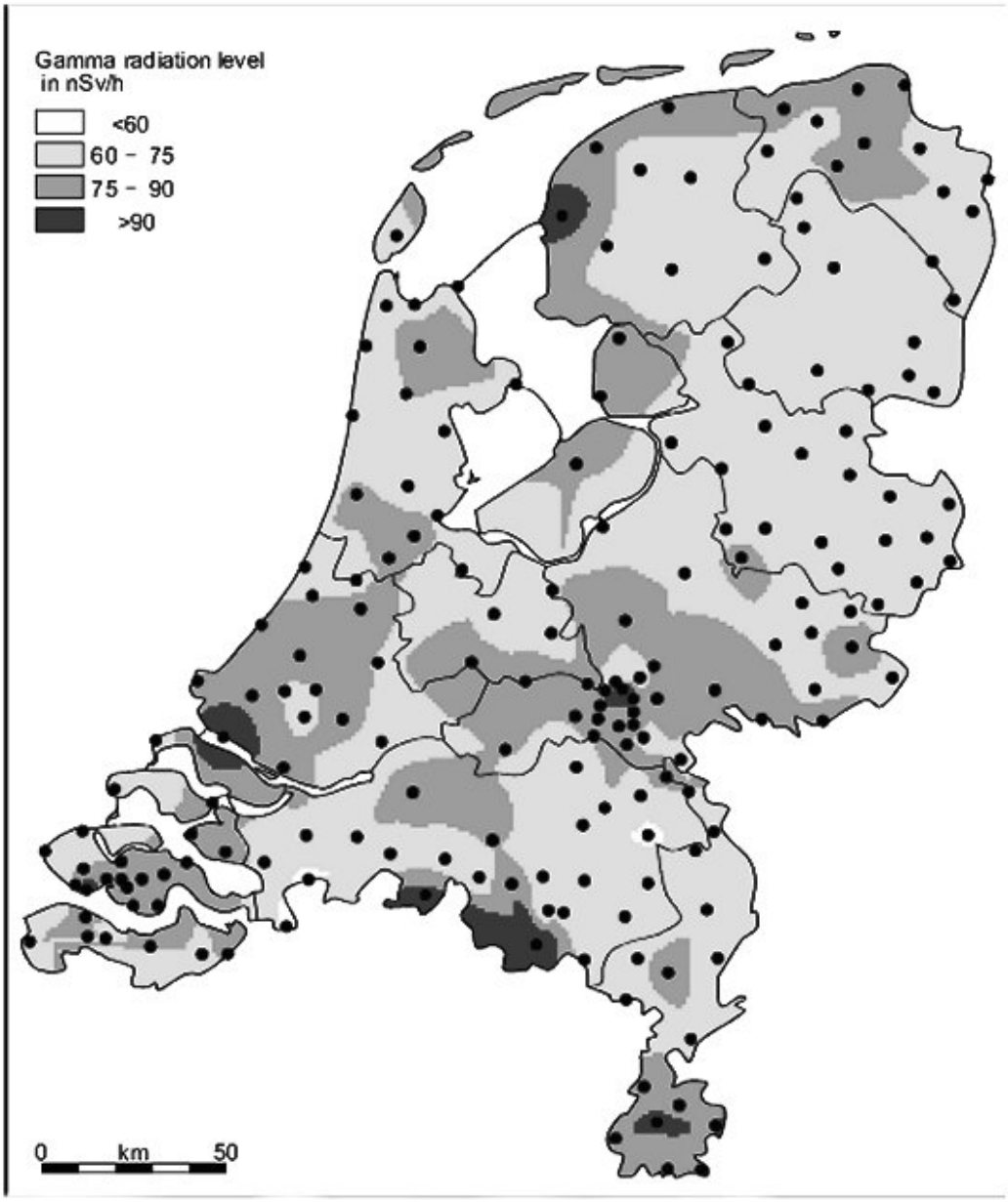

Figure 4.2: The ambient dose equivalent rate in nSv·h^{-1} averaged over 1998.

5. SURFACE WATER AND SEA WATER

5.1 INTRODUCTION

This chapter presents results for surface water and seawater. The Institute for Inland Water Management and Waste Water Treatment (RIZA) and the National Institute for Coastal and Marine Management (RIKZ) regularly monitor the concentration of a number of radioactive nuclides in surface and sea water. The monitoring programme presented here forms only part of the total monitoring programme. The locations have been chosen to represent the major inland waters and sea water. The 1998 monitoring programme is given in *Tables 5.1* and *5.2*. Radioactive nuclides were determined in water and suspended solids. The samples taken in Eijsden and in Lobith were collected during one week; the rest was taken at random. Residual β is defined as gross β minus ^{40}K

Table 5.1: Monitoring programme for the determination of radioactive nuclides in surface water in 1998

Location	Parameter	Compartment	Monitoring frequency (per year)
Meuse	Tritium	Water	13
(Eijsden)	Residual β	Water	13
	Cs-137	Suspended solids	52
Rhine	Tritium	Water	13
(Lobith)	Residual β	Water	13
	Cs-137	Suspended solids	13
Scheldt	Tritium	Water	13
(Schaar van Ouden Doel)	Residual β	Water	13
	Cs-137	Suspended solids	13
Ketelmeer West	Cs-137	Suspended solids	6

Table 5.2: Monitoring programme for the determination of radioactive nuclides in sea water in 1998

Location	Parameter	Compartment	Monitoring frequency (per year)
A (Noordwijk 10)	Tritium	Water	10
	Residual β	Water	10
B (Noordwijk 70)	Tritium	Water	6
	Residual β	Water	6
C (Terschelling 235)	Tritium	Water	6
	Residual β	Water	6

Noordwijk 10 is 10 kilometres offshore, Noordwijk 70 is 70 kilometres offshore and Terschelling 235 is 235 kilometres northwest of Terschelling.

The data for inland waters are presented in *Tables B*10 and *B11*, the data for sea water in *Table B12*. The figures, which give the averages for the years preceding 1998, have been taken from [24].

The samples were analysed at the RIZA laboratory in Lelystad. The radioactive nuclides were determined according to standard procedures [25].
In the Netherlands target values and limits for radioactive materials in surface water are used, which are given in MILBOWA (Environmental quality goals for soil and water) [26], and in the "Vierde Nota waterhuishouding" (Fourth memorandum on water management) [27]. If relevant, averages are compared with these target values and limits.
The results for surface water are presented in *Figures 5.1 to 5.6,* the results for sea water in *Figures 5.7* to *5.10*.

5.2 THE RESULTS FOR SURFACE WATER

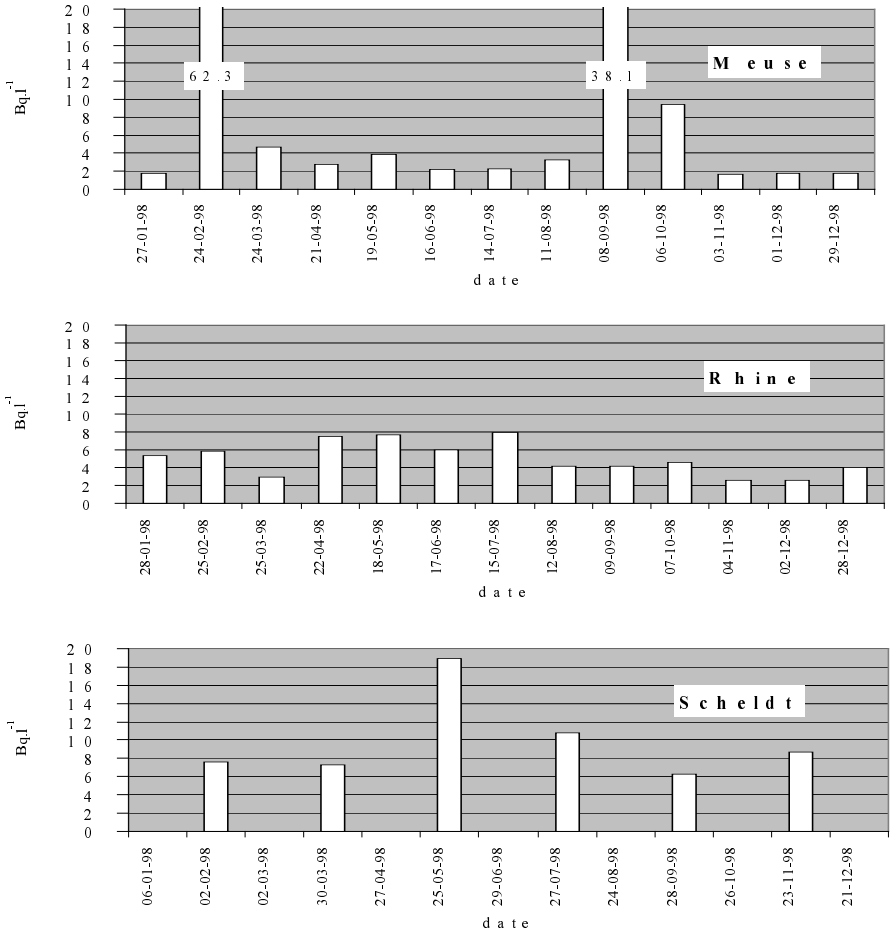

Figure 5.1: The concentration of tritium in 1998 for Meuse, Rhine and Scheldt, with respective averages of 10.5, 5.0 and 9.9 Bq·L^{-1}.

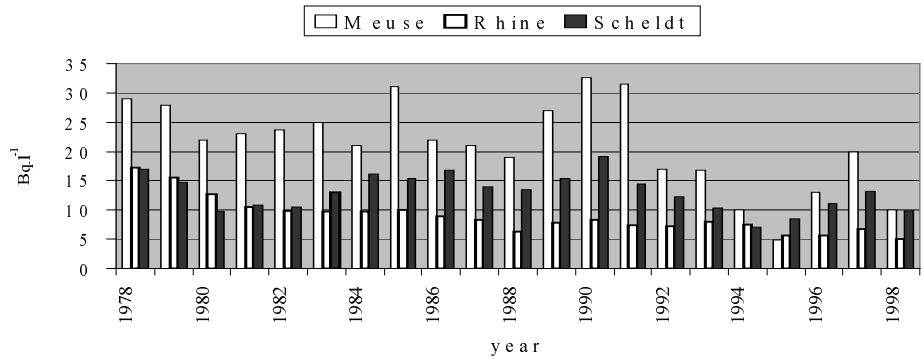

Figure 5.2: The yearly averaged concentration of tritium from 1978 to 1998.

The yearly averaged concentrations of tritium in 1998 in the three rivers are comparable to those in previous years. The concentrations are well below the MILBOWA limit of 200 Bq·L^{-1}. The average tritium concentration in the Meuse is above the target value of 10 Bq·L^{-1}.

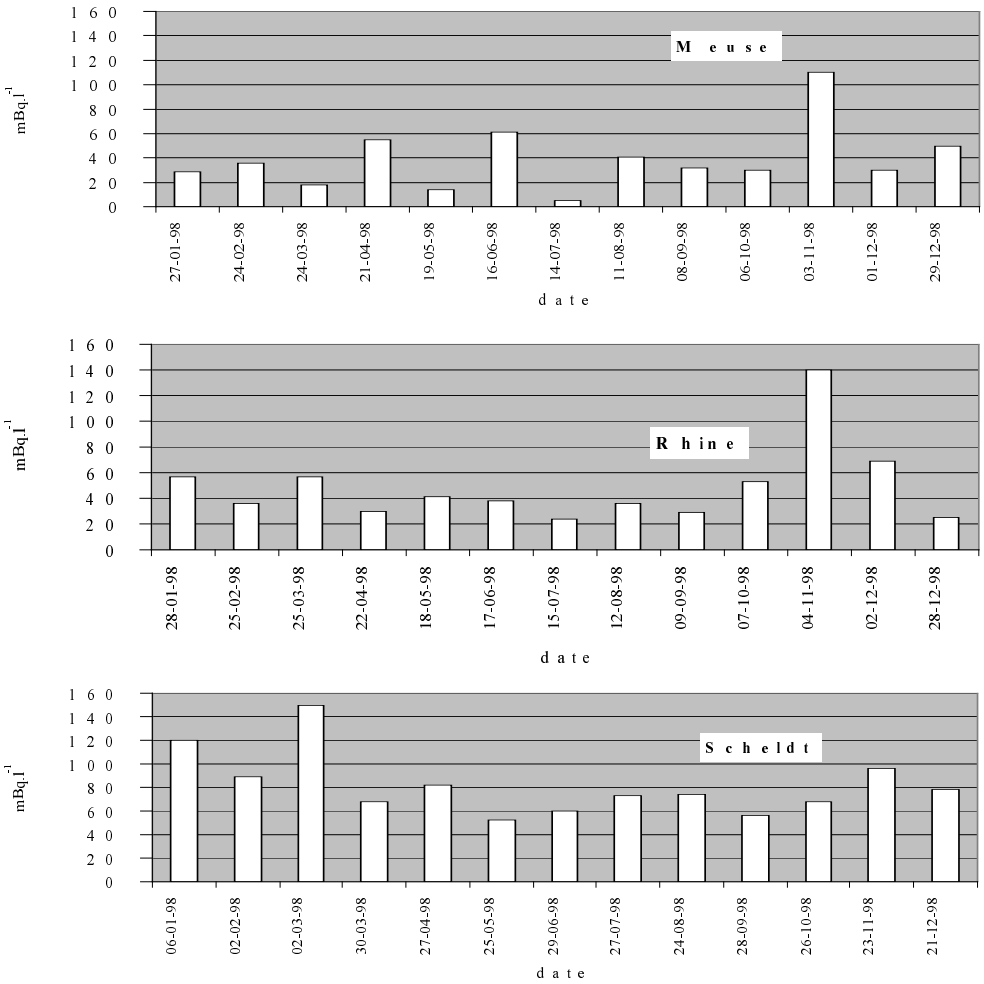

Figure 5.3: The concentration of residual β in 1998 for Meuse, Rhine and Scheldt, with respective averages of 39, 49 and 82 mBq·L^{-1}.

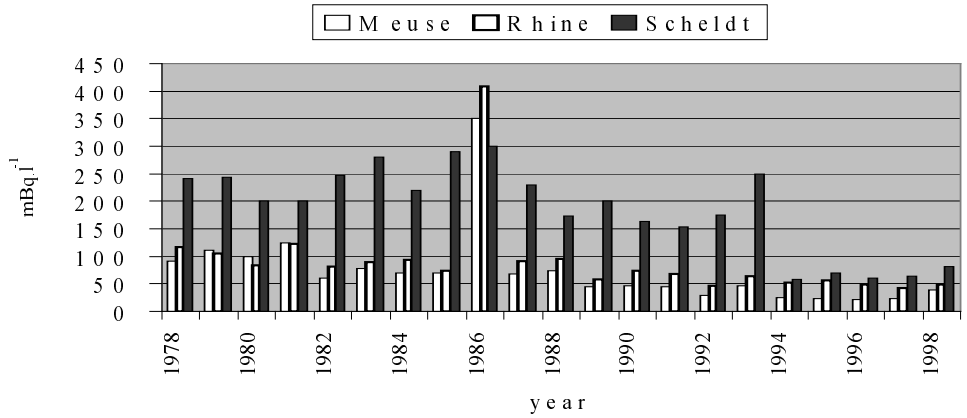

Figure 5.4: Yearly averaged concentration of residual β from 1978 to 1998.

The yearly averaged concentrations of residual β in 1998 for the three rivers are comparable to those for 1994 to 1997. The concentrations are well below the limit of 1000 mBq·L^{-1} and are also below the target value of 200 mBq·L^{-1}.

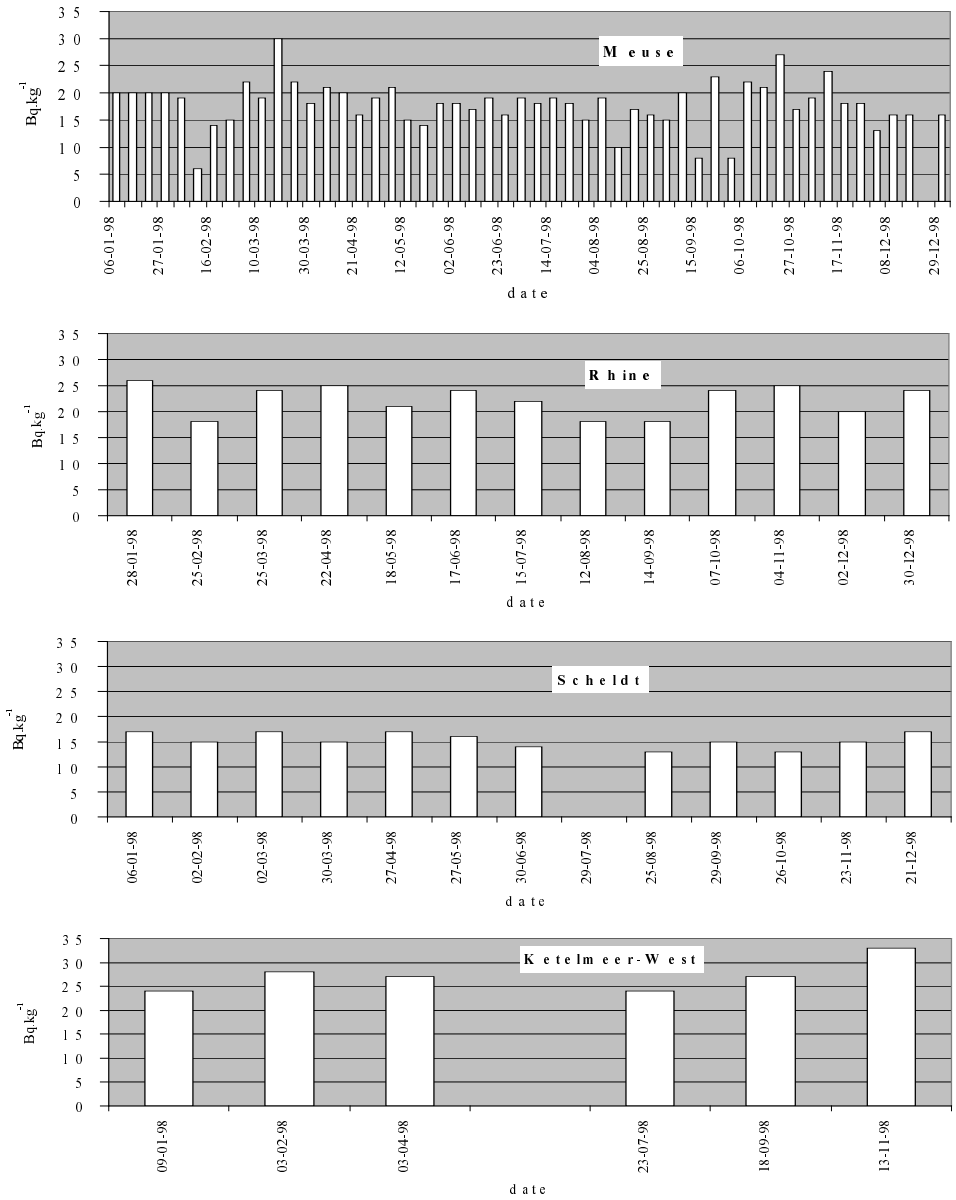

Figure 5.5: The concentration of ^{137}Cs in 1998 for the Meuse, Rhine, Scheldt and Ketelmeer-west with respective averages of 18, 22, 15 and 27 Bq·kg^{-1}.

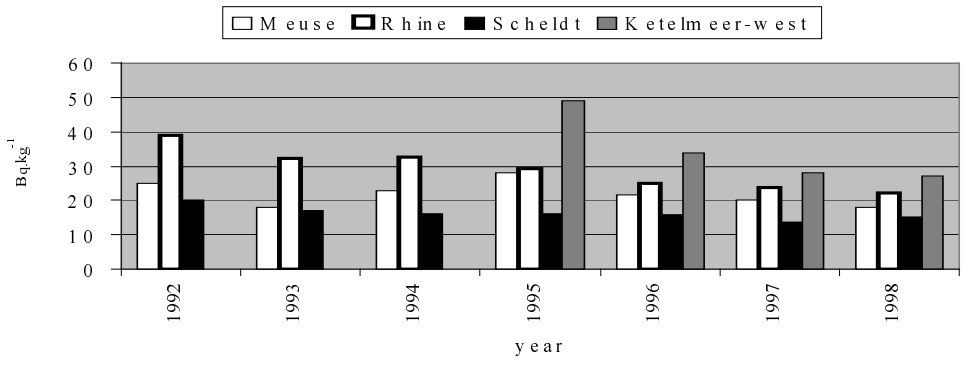

Figure 5.6: Yearly averaged concentration of ^{137}Cs for 1992 to 1998.

The averages are below the target value of 40 Bq·kg^{-1}.

5.3 THE RESULTS FOR SEAWATER

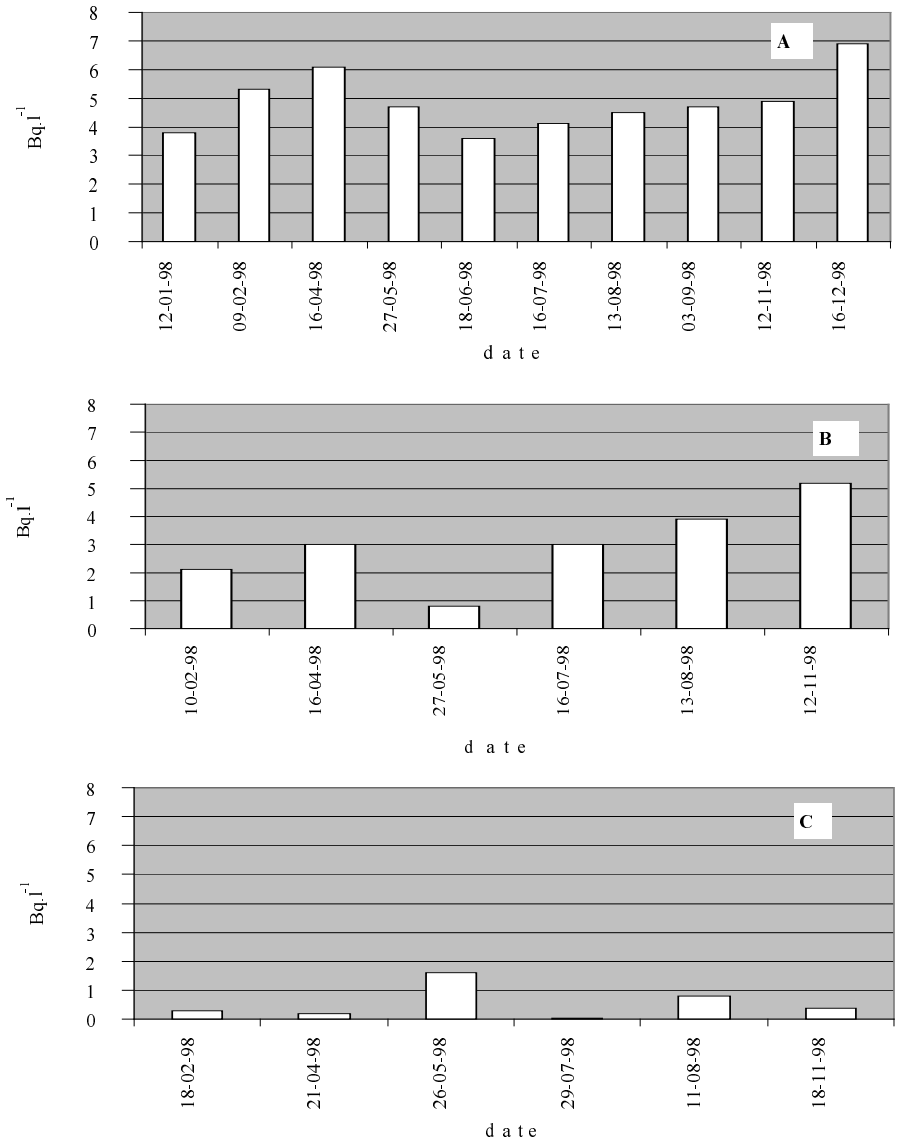

Figure 5.7: The concentration of tritium for three locations in the North Sea.

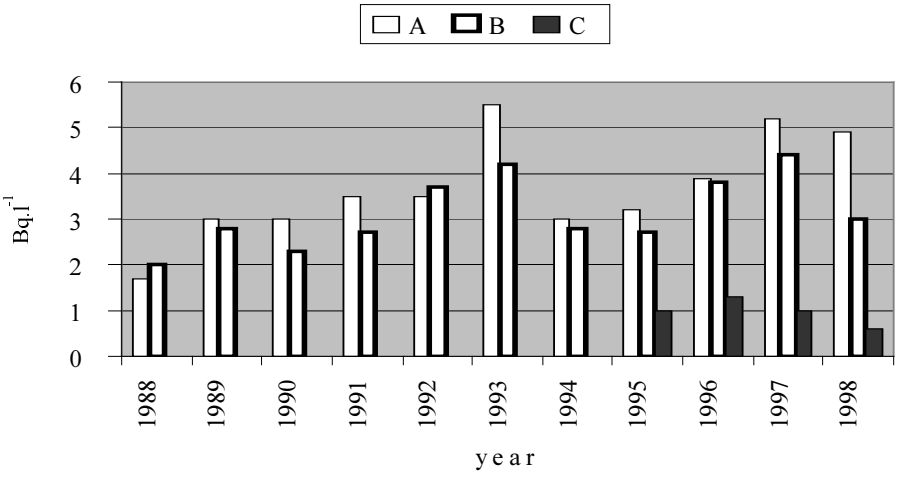

Figure 5.8: Yearly averaged concentration of tritium for 1988 to 1998.

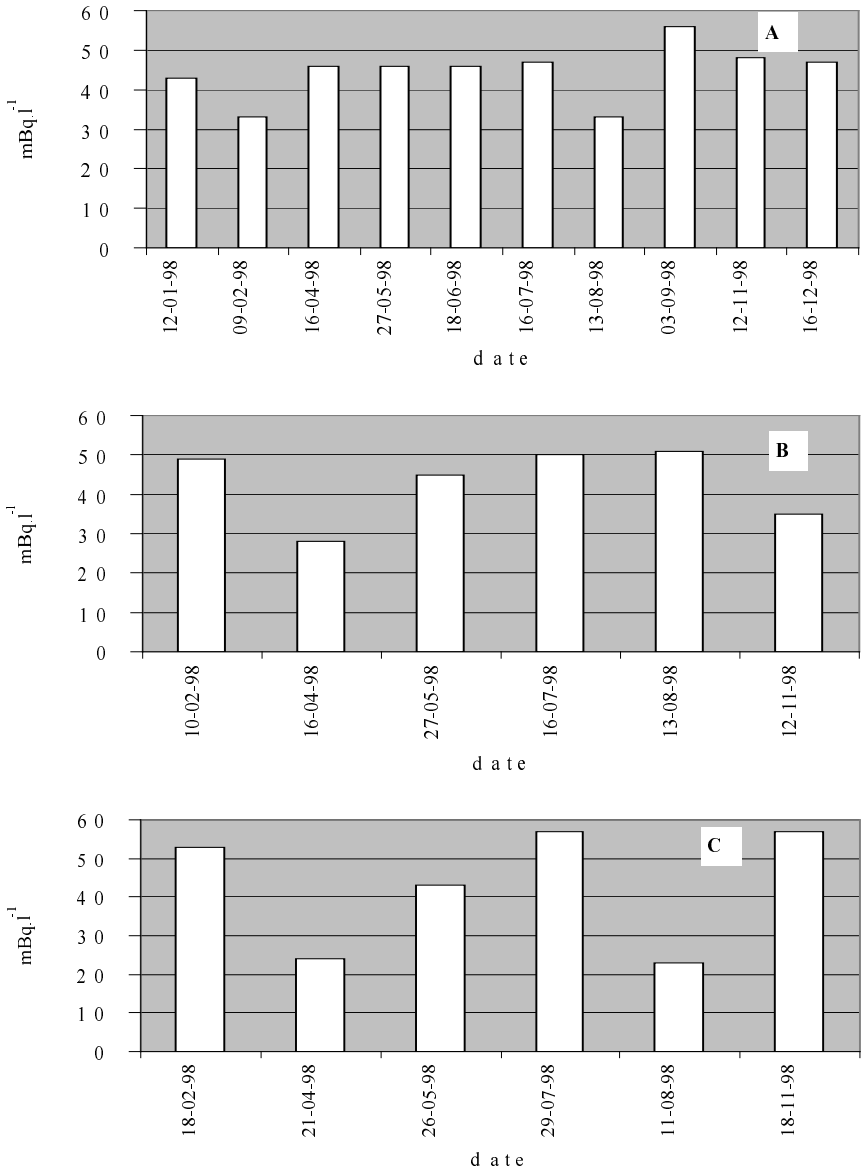

Figure 5.9: The concentration of residual β for three locations in the North Sea.

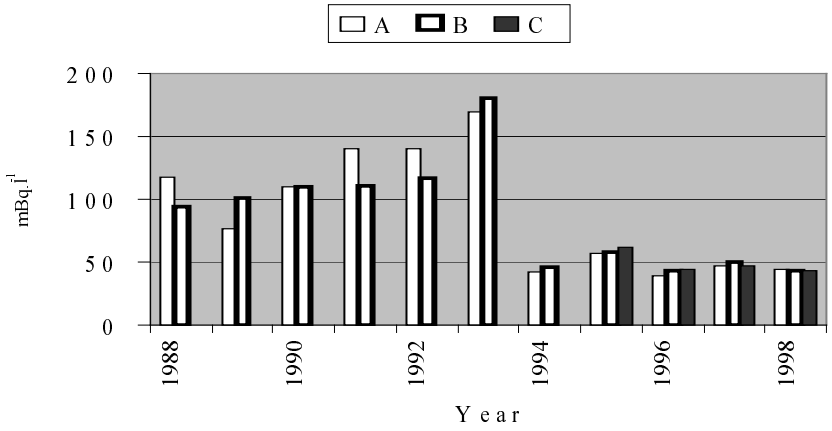

Figure 5.10: Yearly averaged concentration of residual β for 1988 to 1998

6. WATER FOR HUMAN CONSUMPTION

In the Netherlands, water pumping-stations routinely monitor raw water for tritium, gross β and residual β activity. The monitoring frequency is from one to 20 times per year depending on the volume of water produced. Typical activities are 1-10 $Bq \cdot l^{-1}$ for tritium, and 0.1 – 1 $Bq \cdot l^{-1}$ for both gross β and residual β activity.

The activity of natural nuclides, such as ^{226}Ra and ^{222}Rn, in Dutch drinking water is very low. In 1995, a survey of Dutch water was carried out to determine the radon activity [28]. The average concentration was 2.2 $Bq \cdot l^{-1}$.

The Council Directive 98/83/EC on the quality of water intended for human consumption came into effect in the autum of 1998. The indicative parameters for radioactivity are ^{3}H with a parametric value of 100 $Bq \cdot l^{-1}$ and a total indicative dose of 0.1 $mSv \cdot a^{-1}$.
A group of experts of Article 31 and 35/36 have translated the compliance with the indicative dose into operational requirements (α, β activity concentration, nuclide specific dose) and defined appropriate monitoring frequencies, methods and locations for the nuclide categories of interest. This has resulted in a two step approach: step I consisting of gross α and β and ^{3}H measurements with screening values of 0.1, 1 and 100 $Bq \cdot L^{-1}$ respectively.
If screening values are exceeded step II is carried out. This step consists of radionuclide specific measurements after chemical separation and measurement of ^{226}Ra and uranium.
The dose has to be assessed if one or more radionuclides exceed(s) 20 % of the reference concentration [29].

7. MILK

Until 1997 RIVM measured radioactivity in milksamples under authority of the Chief Veterinary Inspectorate for Public Health of the Ministry of Health, Welfare and Sport.
The following monitoring programme was used. Five-litre samples were taken by the Veterinary Public Health Inspectorate each month from four milk factories, Frico in Groningen (north), Coberco in Deventer (east), Campina in Bergeijk (south), and De Graafstroom in Bleskesgraaf (west). A mixture of these samples was taken to be representative for milk in the Netherlands. Three monthly samples were mixed to a quarterly sample and analysed by RIVM for ^{89}Sr, ^{90}Sr and γ-emitters.

In 1997, the average result for ^{137}Cs was 0.098 ± 0.014 Bq·L^{-1}, which was down to the level just before the Chernobyl accident. This is illustrated in *Figure 7.1* (see also [3]). For ^{40}K the average yearly result (57.8 ± 1.9 Bq·L^{-1}) was not significantly different from the results of previous years. The activity concentrations of ^{89}Sr, ^{90}Sr, ^{134}Cs and ^{7}Be were below the detection limit.

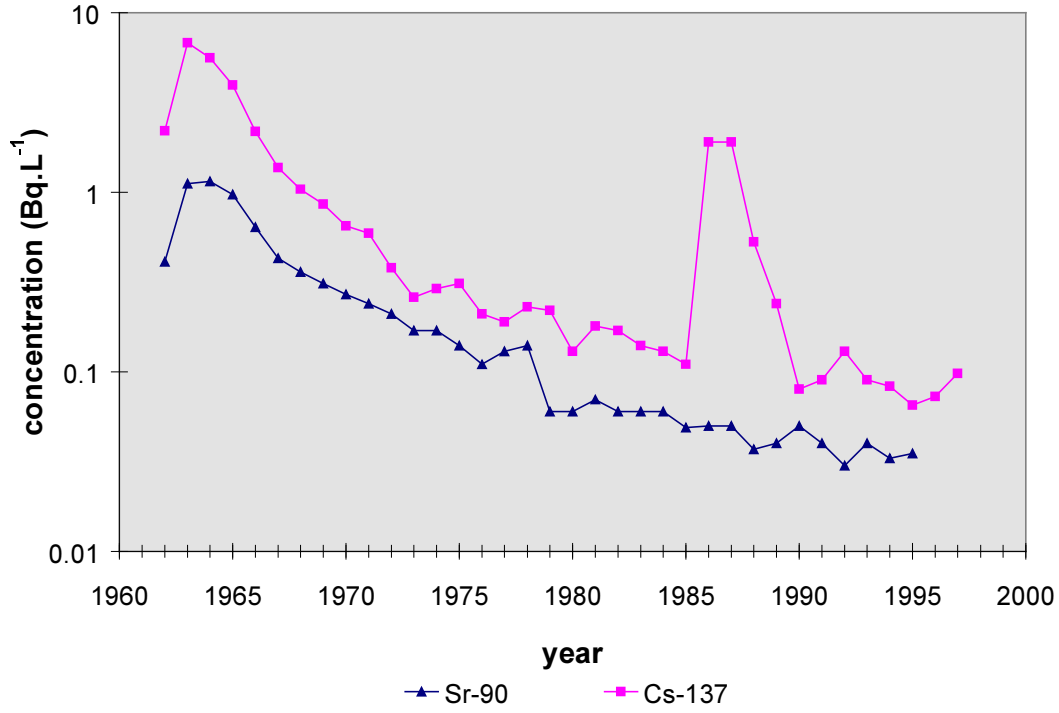

Figure 7.1: The yearly average concentrations of ^{90}Sr and ^{137}Cs in milk in the Netherlands for 1962 to 1997. For ^{90}Sr no value above the detection limit of 0.2 Bq·L^{-1} was measured in 1996 and 1997. Note the logarithmic scale.

Because of the low levels of radioactivity found in the milk samples, the Chief Veterinary Inspectorate for Public Health of the Ministry of Health, Welfare and Sport decided to stop the monitoring programme in 1998.

8. RADIOACTIVITY IN FOOD

Radioactivity is measured in food suspected to contain more than the normal amount. The measurements are performed by The Inspectorate for Health Protection, Commodities and Veterinary Public Health.

Results in 1998

Mushrooms

The European Community (Directorate General XXIV – Consumer Policy and Consumer Health Protection) issued a warning using the ”Rapid Alert system for Food”, that mushrooms from Eastern Europe contained enhanced levels of radioactivity. As a result 16 samples of mushrooms were analysed [30]. The activity (sum of ^{134}Cs and ^{137}Cs) was found to be below the limit of 600 Bq·kg^{-1} (*Table 8.1*). Only one sample of mushrooms, from Lithuania, contained almost twice the limit. Measurements were done according to standard procedures [31]. The limit of 600 Bq·kg^{-1} in food other than baby food and milk products applied to the sum of ^{134}Cs and ^{137} Cs coming from the Chernobyl accident [32].

Table 8.1 Results of analysis of mushrooms for ^{134}Cs and ^{137}Cs

Mushroom variety	**Country**	**^{134}Cs (Bq·kg^{-1})**	**^{137}Cs (Bq·kg^{-1})**
Dried mushrooms	China	n.d.	n.d.
Cepes	France	n.d.	21
Cep	Netherlands	n.d.	41
Chantarelle	Unknown	n.d.	40
Chanterelle	Unknown	n.d.	76
Chanterelle	Unknown	n.d.	43
Chanterelle	Lithuania	12	1123(*)
Chanterelle	France	n.d.	515
Chanterelle	Poland	n.d.	77
Mouzons	Poland	n.d.	n.d.
Trompette de mort	Croatia	n.d.	21
Trompette de mort	France	n.d.	20
Trompette de mort	Netherlands	n.d.	n.d.
Pied de mouton	Slovenia	n.d.	98
Pied de mouton	France	n.d.	127
Hedgehog	Unknown	n.d.	n.d.

(*) A small batch already sold in the Netherlands. Consumption of 5 kg in a year of these mushrooms would cause a dose of about 0,07 mSv.
n.d.= not detectable

Other products

Besides the mushrooms a total of 79 samples of food have been analysed for radioactive nuclides, none was found to have a level higher than 600 $Bq \cdot kg^{-1}$ [29].

The activity concentration ^{137}Cs in heather honey coming from Hatert (Netherlands) was 110 $Bq \cdot kg^{-1}$. One out of four tea samples coming from Turkey contained 69 $Bq \cdot kg^{-1}$ of ^{137}Cs. Other samples were alcoholic beverages (n=3) coming from Eastern Europe, spices and dried vegetables (n=37) and miscellaneous products (n=18) like lime honey, chocolate, gravy powder and sauces, pastries and candy. None of these samples contained radioactivity above the detection limit.

9. COMPLIANCE WITH THE DRAFT EC RECOMMENDATION

The recommendation of the Commission of the European Communities on the application of Article 36 of the Euratom Treaty is still in draft form. The text of the recommendation can be found in Appendix A. Compliance of the Dutch monitoring programme with the recommendation is discussed below. For every sampling medium mentioned in the recommendation, the programme as described in the recommendation will first be given. The Dutch programme will then be described and finally the compliance for this sampling medium will be discussed.

(a) **Airborne particulates**

Recomm.: Measurement of gamma emitting radionuclides shall be performed on a routine basis to detect and measure man-made radioisotopes as well as naturally occurring radionuclides. Beryllium-7 shall be reported as a qualitative check of the methods used. Where gross beta activity measurements are recorded these shall also be reported. Sampling locations should be in the vicinity of densely populated areas; adequate geographical coverage shall be ensured by the choice of at least one sampling location per geographical region.
Sampling shall be performed by systems operating continuously.

NL: In the Netherlands airborne particulates are sampled continuously with a HVS at the RIVM premises in Bilthoven. Samples collected during a week are analysed for γ-emitters, gross α and gross β.

Conclusion: The monitoring programme is in compliance with the recommendation.

(b) **External ambient gamma doses**

Recomm.: External ambient gamma doses shall be measured continuously.

NL: The NMR continuously monitors the ambient dose rate.

Conclusion: The monitoring programme is in compliance with the recommendation.

(c) **Surface water**

Recomm.: Samples shall be taken from major inland waters of the Member State's territory and, if relevant, from coastal waters. In the case of river water, sampling shall be carried out, where practicable, at locations for which flow rate measurements are available; in such cases the average flow rate during the sampling period shall be reported to improve the representativeness of the mean values calculated by the Commission.
Gamma emitting radionuclides shall be monitored. Where residual beta activity measurements are recorded these shall also be reported.

NL: In the Netherlands the major inland waters and coastal waters are regularly monitored for a number of radioactive nuclides.

Conclusion: The monitoring programme is in compliance with the recommendation. Average flow rates during the sampling periods will have to be reported.

(d) **Water intended for human consumption**

Recomm.: Monitoring of levels of radioactivity in drinking water shall be such as to ensure compliance with the requirements of the Council Directive 98/83/EC.
For the purpose of compliance with Article 36 of the Euratom Treaty values shall be reported for major ground or surface water supplies and for water distribution

networks such as to ensure a representative coverage of the Member State. The corresponding volumes of water distributed or produced in a year shall be reported to improve the representativeness of the mean values calculated by the Commission.

NL: In the Netherlands, water pumping-stations routinely monitor raw water for tritium, gross β and residual β activity. The monitoring frequency is between once per year and 20 times per year depending on the volume of water that is pumped.
The Council Directive is currently being implemented in Dutch legislation. A two step approach as described in Chapter 6 of this report is suggested to be used in the monitoring programme. A consultation with the pumping stations should be held to determine the precise monitoring programme. The produced volume of water will have to be reported.

Conclusion: The current monitoring programme is not in compliance with the recommendation.

(e) **Milk**

Recomm.: Milk samples shall be taken from dairies. The necessary statistical information on production rates shall be reported to improve the representativeness of the mean values calculated by the Commission. The spread of dairies shall be sufficient to ensure representative coverage of the Member State.
Gamma emitters and strontium-90 shall be monitored; potassium-40 shall be reported as a qualitative check of the methods used.

NL: In the Netherlands there is currently no monitoring programme for milk.
Until 1997 five-litre samples were taken each month from four representative milk factories. Three monthly samples were mixed to a quarterly sample and analysed for ^{89}Sr, ^{90}Sr and γ-emitters.

Conclusion: The monitoring programme is not in compliance with the recommendation. The programme used until 1997 corresponds to the programme as described in the recommendation. Production rates will have to be reported.

(f) **Mixed diet**

Recomm.: Due to the trade in foodstuffs, the mixed diet is not necessarily representative of the regional or national environmental contamination but is an indicator of the public exposure. Where appropriate foodstuffs shall be measured as separate ingredients; in this case the Member State shall report to the Commission the results of measurements of the individual ingredients and the composition of the diet. The sampling programme shall take into consideration regional variations in dietary patterns. Individual ingredients shall be from market places or local distribution centres providing food products to large population groups.
Appropriate account shall be taken of products from natural or semi-natural ecosystems, to the extent that the fallout from the Chernobyl accident may still affect such systems. In addition Member States shall sample complete meals to give a representative figure for the average level of radioactivity in mixed diet. Actual meal samples shall be taken from large consumption centres such as canteens or restaurants.
Gamma emitters and strontium-90 shall be monitored; the measurements shall be not less frequent than quarterly. Where carbon-14 measurements are performed these shall also be reported

NL: In the Netherlands radioactivity is measured only in food suspected to have a more than normal level of radioactivity.

Conclusion: A programme for mixed diet does not exist in the Netherlands. There is no compliance with the recommendation

10. CONCLUSIONS

This report presents the first, nearly complete, survey of measurements of radioactivity in the environment in the Netherlands since the dissolution of the CCRX in 1995. As far as food is concerned, only one sample of mushrooms from Lithuania contained concentrations of almost twice the limit of 600 $Bq \cdot kg^{-1}$. For all other monitoring measurements no elevated levels of radioactivity were found. The activity concentrations are back to the levels of just before the Chernobyl accident.

The Dutch monitoring programme is in compliance with the programme described in the draft EC recommendation for measurements in air, surface water and assessment of external γ-dose. There is no compliance for the monitoring of drinking water, milk and mixed diet.

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APPENDIX A

6064/99 EN

DRAFT
COMMISSION RECOMMENDATION on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole

(99/ /EURATOM)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Atomic Energy Community, and in particular Article 124 thereof,
Having regard to Chapter III of the Treaty, and in particular Articles 35, 36 and 39 thereof,

(1) Whereas Article 35 of the Euratom Treaty requires each Member State to establish the facilities necessary to carry out continuous monitoring of the level of radioactivity in the air, water and soil and to ensure compliance with the basic standards;
(2) Whereas Article 36 of the Euratom Treaty requires that the appropriate authorities shall periodically communicate information on the checks referred to in Article 35 to the Commission so that it is kept informed of the level of radioactivity to which the public is exposed;
(3) Whereas experience has been gained in the application of Article 36; whereas it is current practice that the Commission publishes annual Monitoring Reports, on the basis of quality controlled data received by the Commission in application of Article 36 and Article 39; whereas the Commission shall pursue the publication of such annual Monitoring Reports;
(4) Whereas to ensure that the exposure of the population is kept under review it is important that the Commission be informed in a timely fashion and on a uniform basis of the levels of radioactivity to which the population as a whole is exposed in every Member State;
(5) Whereas Article 14 of the Basic Safety Standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Council Directive 96/29/Euratom)[2] requires that contributions to the exposure of the population as a whole from all practices shall be regularly assessed;
(6) Whereas Article 45 of the Basic Safety Standards[1] requires that competent authorities shall ensure that dose estimates for the population as a whole are made as realistic as possible;
(7) Whereas, without prejudice to the requirements of Article 35 of the Euratom Treaty, it is sufficient for the review of the exposure of the population as a whole to provide a defined set of specific monitoring results;
(8) Whereas to ensure compliance with the Basic Safety Standards it is important that in addition to air, water and soil, levels of radioactivity be determined in biological samples and in particular in foodstuffs, and that to assess external exposure the ambient dose rates be monitored
(9) Whereas the monitoring of levels of radioactivity in soil does not allow a direct assessment of the exposure of the population; whereas the exposure related to soil contamination is more directly assessed on the basis of ambient dose rate and foodstuff contamination; whereas experience has shown that the incorporation of soil data in the monitoring serves little useful purpose;
(10) Whereas it is necessary to keep under review which sampling media and which radionuclide categories are relevant indicators of actual and potential levels of radioactivity in the environment and of exposure of the population;
(11) Whereas there is consensus among Member States as to the adequacy of current monitoring programmes; whereas such monitoring may change as a function of the evolution of levels of radioactivity, measurement technology, and the needs in view of emergency response; whereas the Commission will keep under review the adequacy of monitoring programmes and involve the Group of Experts established under Article 31 of the Euratom Treaty in this process;
(12) Whereas the data on discharges of radionuclides to the environment from nuclear power plants and reprocessing plants are already requested[3] in the framework of Article 37 of the Euratom Treaty;

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2 OJ L 159, 29.6.96, P.1/28 to be implemented by May 2000

(13) Whereas Council Directive 98/83/EC of 3 November 1998, on the quality of water intended for human consumption[4], provides for indicator parameters for radioactivity; whereas this Recommendation is without prejudice to specific requirements to be laid down in Annex II and Annex III of this Directive;
(14) Whereas the uniformity, comparability, transparency and timeliness of data reported in accordance with Article 36 of the Euratom Treaty shall be ensured;

HEREBY RECOMMENDS:

Article 1
That Member States, to discharge their obligation under the terms of Article 36 of the Euratom Treaty to communicate periodically information on the results of the monitoring of the levels of radioactivity, which they are bound to perform under the terms of Article 35 of that Treaty, forward to the Commission, in accordance with the time constraints defined in Article 5.3 below, the monitoring results listed in Annex 1. In case of an elevated concentration of a radionuclide not specified in Annex 1 appropriate data shall also be forwarded.

Article 2

Definitions.

For the purpose of this Recommendation.

1. “Continuous monitoring” shall mean: the existence and implementation of a continuing monitoring programme. Depending on the medium monitored this shall be achieved as appropriate through:

   (a) Continuous sampling and assessment,

   (b) Continuous sampling and periodic assessment,

   (c) Periodic sampling and periodic assessment,

   (d) Direct continuous measurement.

2. “Facilities” shall mean: the monitoring programme, the direct measurement and sampling and analysis equipment and procedures (including quality control and the reporting and archiving of all relevant data), and the laboratories necessary to implement continuous monitoring of the levels of radioactivity.

3. “Monitoring network” shall mean: the combination for each medium of the sampling and direct measurement locations, as appropriate, used for the monitoring of that specific medium.

   "Dense monitoring network" shall mean: a monitoring network comprising sampling locations distributed throughout the Member State’s territory such as to allow the Commission to compute regional averages for radioactivity levels in the EU.

   "Sparse monitoring network" shall mean: a subset of a dense network comprising for every region and for every sampling medium at least one location representative of that region. At such locations high sensitivity measurements should be performed thus giving a transparent representation of actual levels and trends of radioactivity levels.

   “Region” shall mean each representative area of a Member State for the assessment of the radiological exposure of the population as a whole under consideration of radiological impact by emissions and

[3] Commission Recommendation on the application of Article 37 of the Euratom Treaty, 99/ /Euratom (OJ …)
[4] OJ L 330, 5.12.98, P.32/54

ambient dose and the population distribution. The regions currently defined in the Community Monitoring Reports are given in Annex 2.

Article 3

The Member States shall notify to the Commission the appropriate authorities referred to in Article 36 of the Euratom Treaty.

Article 4

1. Monitoring networks

   (a) Each Member State shall define representative geographical regions for its own territory.

   (b) Each Member State shall define for each type of medium a sparse monitoring network and a dense monitoring network.

   (c) The sites comprising a network shall be representative of the regional situation taking into account, where appropriate, the population distribution within the region.

2. Sampling media, types of measurements, and periodicity

   (a) The sampling media and types of measurements are listed in Annex 1. Except where otherwise specified in this recommendation, measurements will preferably be carried out for the sparse network on a monthly basis and for the dense network quarterly.

   (b) For the sparse monitoring network the detection limits and sensitivities of the measurement instruments should allow the actual levels to be quantified.

   (c) For the dense monitoring network the detection limits of the measurement devices shall be lower than the reporting levels defined in Annex 3.

   (d) The Member States shall inform the Commission of the detection limits and of the uncertainties taken into account.

   (e) The Member States shall retain measurement techniques that have proven reliable and shall ensure quality control of the results.

   (f) Member State laboratories supplying data under the terms of this Recommendation shall periodically participate in intercomparison exercises, in particular those organised by the Commission, so as to ensure the intercomparability of the data reported.

3. Sampling strategies and measurements in relation to each of the required sampling media

   (a) Airborne particulates

   Measurement of gamma emitting radionuclides shall be performed on a routine basis to detect and measure man-made radioisotopes as well as naturally occurring radionuclides. Beryllium-7 shall be reported as a qualitative check of the methods used. Where gross beta activity[5] measurements are recorded these shall also be reported.

[5] The total measured beta activity in a sample; depending on the measurement methodology tritium and in general very low energy beta emitters are normally not included and short lived radon daughters are excluded through a sufficient delay time (e.g. 5 days) before counting.

Sampling locations should be in the vicinity of densely populated areas; adequate geographical coverage shall be ensured by the choice of at least one sampling location per geographical region.

Sampling shall be performed by systems operating continuously.

(b) External ambient gamma doses shall be measured continuously. No reporting level is defined.

(c) Surface water.

Samples shall be taken from major inland waters of the Member State's territory and, if relevant, from coastal waters.

In the case of river water, sampling shall be carried out, where practicable, at locations for which flow rate measurements are available; in such cases the average flow rate during the sampling period shall be reported to improve the representativeness of the mean values calculated by the Commission.

Gamma emitting radionuclides shall be monitored. Where residual beta activity[6] measurements are recorded these shall also be reported.

(d) Water intended for human consumption.

Monitoring of levels of radioactivity in drinking water shall be such as to ensure compliance with the requirements of the Council Directive 98/83/EC[7].

For the purpose of compliance with Article 36 of the Euratom Treaty values shall be reported for major ground or surface water supplies and for water distribution networks such as to ensure a representative coverage of the Member State.

The corresponding volumes of water distributed or produced in a year shall be reported to improve the representativeness of the mean values calculated by the Commission.

(e) Milk.

Milk samples shall be taken from dairies. The necessary statistical information on production rates shall be reported to improve the representativeness of the mean values calculated by the Commission. The spread of dairies shall be sufficient to ensure representative coverage of the Member State.

Gamma emitters and strontium-90 shall be monitored; potassium-40 shall be reported as a qualitative check of the methods used.

(f) Mixed diet.

Due to the trade in foodstuffs, the mixed diet is not necessarily representative of the regional or national environmental contamination but is an indicator of the public exposure.

Where appropriate foodstuffs shall be measured as separate ingredients; in this case the Member State shall report to the Commission the results of measurements of the individual ingredients and the composition of the diet. The sampling programme shall take into consideration regional variations in dietary patterns. Individual ingredients shall be from market places or local distribution centres providing food products to large population groups. Appropriate account shall be taken of products from natural or semi-natural ecosystems, to the extent that the fallout from the Chernobyl accident may still affect such systems.

In addition Member States shall sample complete meals to give a representative figure for the average level of radioactivity in mixed diet. Actual meal samples shall be taken from large consumption centres such as canteens or restaurants.

Gamma emitters and strontium-90 shall be monitored; the measurements shall be not less frequent than quarterly. Where carbon-14 measurements are performed these shall also be reported.

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6 The total measured beta activity minus potassium-40 activity

7 OJ L 330, 5.12.98, p. 32/54

Article 5

Reporting procedures.

11. Treatment of data.

The Member States shall forward to the Commission data which have been subject to quality control and cleared for public release. The data set shall contain all details listed in Annex 4.

The Member State shall forward the data in the format defined by the Commission and preferably use the specialised software provided by the Commission.

Individual non-aggregated measurement data shall be transmitted for each medium and each site rather than average values. However, if the data correspond to direct continuous measurements, then the monthly averages for each site shall be communicated.

12. Means of transmission.

Data shall be forwarded in a digital form using the most appropriate electronic media.

13. Periodicity.

All available data shall be forwarded to the Commission as soon as they are validated in order to allow for a prompt assessment by the Commission of the impact of environmental radioactivity on public health. All data for a calendar year shall be submitted no later than the 30th of June of the following year.

14. Transmission of other data.

In addition to the data transmitted under Article 5.1 above, Member States shall transmit to the Commission their national monitoring reports to allow a fuller understanding of the significance of the data referred to in Annex 1 in relation to the national monitoring programmes. The Commission's annual Monitoring Reports shall list references to those national reports.

15. Integration of reporting practices.

Data regularly reported under the terms of Article 36, data voluntarily reported other than National Monitoring reports and large amounts of data of types potentially relevant in emergency situations shall be forwarded through the same communication means and channels and in the same format in order to simplify reporting practices and to avoid duplication of efforts and to conduct regular exercises of the emergency arrangements.

Annex 1

SAMPLE TYPES AND MEASUREMENTS

Media	Measurement category	
	Dense network	Sparse network
Airborne particulates	Cs-137, gross beta	Cs-137, Be-7
Air	Ambient gamma dose	Ambient gamma dose
Surface water	Cs-137, residual beta	Cs-137
Drinking water	Tritium, Sr-90, Cs-137 Natural radionuclides as monitored in compliance with Council Directive 98/83/EC	Tritium, Sr-90, Cs-137 Natural radionuclides as monitored in compliance with Council Directive 98/83/EC
Milk	Cs-137, Sr-90	Cs-137, Sr-90, K-40
Mixed diet	Cs-137, Sr-90	Cs-137, Sr-90, C-14

Annex 3

REPORTING LEVELS

Uniform reporting levels have been defined on the basis of their significance from an exposure point of view, irrespective of the detection limits applied by the different laboratories.

Sample type	Radionuclide category	Reporting level
Air	Gross beta (based on Sr-90) Cs-137	2 E-03 Bq/m³ 1 E-02 Bq/m³
Surface water	Residual beta (based on Sr-90) Cs-137	5 E-01 Bq/l 1 E+00 Bq/l
Drinking water	H-3 Sr-90	1 E+02 Bq/l 5 E-02 Bq/l
Milk	Sr-90 Cs-137	1 E-01 Bq/l 5 E-01 Bq/l
Mixed diet	Sr-90 Cs-137	8 E-02 Bq/d.p 2 E-01 Bq/d.p

Bq/d.p=Becquerel per day per person.

APPENDIX B

Table B1: Weekly results of gross α- and gross β-activities in airdust sampled with HVS in 1998 on the RIVM premises in Bilthoven (The Netherlands).*

Week number	Gross α mBq·m^{-3}	Gross β mBq·m^{-3}
1	0.052 ± 0.005	0.184 ± 0.013
2	0.105 ± 0.010	0.68 ± 0.04
3	0.046 ± 0.005	0.256 ± 0.017
4	0.063 ± 0.007	0.51 ± 0.03
5	0.124 ± 0.010	0.38 ± 0.03
6	0.135 ± 0.012	0.71 ± 0.05
7	0.150 ± 0.012	0.84 ± 0.05
8	0.093 ± 0.009	0.47 ± 0.03
9	0.048 ± 0.006	0.236 ± 0.016
10	0.042 ± 0.006	0.249 ± 0.017
11	0.109 ± 0.010	0.39 ± 0.03
12	0.099 ± 0.009	0.40 ± 0.03
13	0.081 ± 0.008	0.38 ± 0.02
14	0.035 ± 0.006	0.204 ± 0.015
15	0.034 ± 0.005	0.228 ± 0.016
16	0.072 ± 0.008	0.36 ± 0.02
17	0.066 ± 0.008	0.282 ± 0.020
18	0.083 ± 0.007	0.43 ± 0.03
19	0.059 ± 0.007	1.03 ± 0.07
20	0.074 ± 0.009	0.59 ± 0.04
21	0.079 ± 0.007	0.45 ± 0.03
22	0.071 ± 0.007	0.30 ± 0.02
23	0.095 ± 0.009	0.276 ± 0.019
24	0.069 ± 0.007	0.277 ± 0.019
25	0.113 ± 0.010	0.45 ± 0.03
26	0.074 ± 0.008	0.181 ± 0.013
27	0.047 ± 0.006	0.241 ± 0.017
28	0.090 ± 0.009	0.252 ± 0.017
29	0.142 ± 0.012	0.38 ± 0.03
30	0.079 ± 0.008	0.235 ± 0.016
31	0.059 ± 0.007	0.290 ± 0.020
32	0.114 ± 0.010	0.44 ± 0.03
33	0.118 ± 0.010	0.35 ± 0.02
34	0.051 ± 0.007	0.25 ± 0.02
35	0.081 ± 0.008	0.47 ± 0.03
36	0.068 ± 0.008	0.32 ± 0.02
37	0.028 ± 0.006	0.151 ± 0.012
38	0.108 ± 0.010	0.53 ± 0.03
39	0.097 ± 0.009	0.76 ± 0.05
40	0.049 ± 0.007	0.43 ± 0.03
41	0.107 ± 0.010	0.251 ± 0.017
42	0.092 ± 0.009	0.48 ± 0.03
43	0.046 ± 0.006	0.258 ± 0.018
44	0.058 ± 0.007	0.188 ± 0.014
45	0.100 ± 0.009	0.278 ± 0.019
46	0.087 ± 0.009	0.38 ± 0.03
47	0.171 ± 0.018	1.15 ± 0.07
48	0.099 ± 0.009	0.72 ± 0.05
49	0.033 ± 0.007	0.224 ± 0.016
50	0.076 ± 0.008	0.34 ± 0.02
51	0.084 ± 0.009	0.267 ± 0.019
52	0.066 ± 0.008	0.32 ± 0.02
Avg.	0.0812 ± 0.0012	0.398 ± 0.004
SD	0.03	0.2

** The error in the yearly average is equal to the square root of the sum of the squared weekly errors divided by the number of weeks. SD is the standard deviation of the weekly results. Errors are given as 1σ.*

Table B2: Weekly results of ^{7}Be, ^{137}Cs and ^{210}Pb concentrations in air dust sampled with HVS in 1998 on the RIVM premises in Bilthoven (The Netherlands).*

Week number	Period	^{7}Be $\mu Bq \cdot m^{-3}$			^{137}Cs $\mu Bq \cdot m^{-3}$			^{210}Pb $\mu Bq \cdot m^{-3}$		
1	31/12 - 09/01	3400	±	300	0.49	±	0.10	70	±	7
2	09/01 - 15/01	4800	±	400	0.99	±	0.18	360	±	30
3	15/01 - 23/01	3000	±	300	0.95	±	0.15	107	±	10
4	23/01 - 30/01	3900	±	300	1.77	±	0.22	250	±	20
5	30/01 - 06/02	4000	±	300	1.01	±	0.14	155	±	14
6	06/02 - 12/02	5400	±	500	1.16	±	0.15	350	±	30
7	12/02 - 20/02	7000	±	600	1.25	±	0.18	480	±	40
8	20/02 - 27/02	4100	±	400	1.01	±	0.15	240	±	20
9	27/02 - 06/03	4100	±	400	0.99	±	0.15	115	±	11
10	06/03 - 13/03	3600	±	300	0.62	±	0.16	91	±	8
11	13/03 - 20/03	4000	±	400	1.10	±	0.15	182	±	16
12	20/03 - 27/03	4900	±	400	1.9	±	0.2	194	±	17
13	27/03 - 03/04	3300	±	300	1.13	±	0.16	240	±	20
14	03/04 - 10/04	3900	±	300	0.59	±	0.13	76	±	7
15	10/04 - 17/04	4400	±	400	0.69	±	0.12	97	±	9
16	17/04 - 24/04	4600	±	400	1.02	±	0.14	173	±	16
17	24/04 - 29/04	4700	±	400	0.6	±	0.15	125	±	12
18	29/04 - 08/05	5200	±	500	0.7	±	0.09	204	±	18
19	08/05 - 15/05	9300	±	800	5.9	±	0.5	530	±	50
20	15/05 - 20/05	6900	±	600	3.2	±	0.3	520	±	50
21	20/05 - 29/05	5200	±	500	0.80	±	0.14	330	±	30
22	29/05 - 05/06	3900	±	300	6.0	±	0.5	320	±	30
23	05/06 - 12/06	3200	±	300	0.75	±	0.15	220	±	20
24	12/06 - 19/06	3300	±	300	0.65	±	0.13	230	±	20
25	19/06 - 26/06	5100	±	400	0.91	±	0.19	430	±	40
26	26/06 - 03/07	2500	±	200	0.37	±	0.08	172	±	16

Table B2: Continued

Week number	Period	^{7}Be μBq·m^{-3}			^{137}Cs μBq·m^{-3}			^{210}Pb μBq·m^{-3}		
27	03/07 - 10/07	3700	±	300	0.72	±	0.15	240	±	20
28	10/07 - 17/07	3700	±	300	1.15	±	0.18	210	±	20
29	17/07 - 24/07	5000	±	400	1.2	±	0.2	370	±	30
30	24/07 - 31/07	2700	±	200	3.5	±	1.4	780	±	70
31	31/07 - 07/08	3500	±	300	1.1	±	0.2	290	±	30
32	07/08 - 14/08	5200	±	400	1.02	±	0.11	450	±	40
33	14/08 - 21/08	3600	±	300	1.42	±	0.18	260	±	20
34	21/08 - 28/08	3200	±	300	0.60	±	0.11	165	±	16
35	28/08 - 04/09	4900	±	400	0.96	±	0.14	580	±	50
36	04/09 - 11/09	3100	±	300	0.55	±	0.09	340	±	30
37	11/09 - 18/09	2400	±	200	0.64	±	0.12	142	±	13
38	18/09 - 25/09	4200	±	400	1.15	±	0.17	590	±	50
39	25/09 - 02/10	4200	±	400	1.05	±	0.13	1050	±	90
40	02/10 - 09/10	2600	±	200	0.77	±	0.23	460	±	40
41	09/10 - 16/10	2600	±	200	0.91	±	0.17	240	±	20
42	16/10 - 23/10	4300	±	400	0.88	±	0.13	410	±	40
43	23/10 - 30/10	4100	±	400	1.0	±	0.3	157	±	16
44	30/10 - 06/11	2100	±	200	0.53	±	0.09	161	±	14
45	06/11 - 13/11	3100	±	300	0.82	±	0.10	270	±	20
46	13/11 - 20/11	3500	±	300	1.04	±	0.15	330	±	30
47	20/11 - 27/11	4800	±	400	3.1	±	0.3	1230	±	110
48	27/11 - 04/12	2400	±	200	1.7	±	0.2	830	±	70
49	04/12 - 10/12	2500	±	200	0.92	±	0.14	180	±	20
50	10/12 - 18/12	3200	±	300	0.67	±	0.13	360	±	30
51	18/12 - 24/12	3100	±	300	0.83	±	0.18	240	±	20
52	24/12 - 31/12	3700	±	300	0.64	±	0.09	310	±	30
	Avg.	4020	±	50	1.26	±	0.04	325	±	5
	SD	1300			1.14			235		

** The error in the yearly average is equal to the square root of the sum of the squared weekly errors divided by the number of weeks. SD is the standard deviation of the weekly results. Errors are given as 1σ.*

Table B3: Detection limits in µBq·m^{-3} of the well-type detector for a seven days sampling period, ten days delay between sampling and start of measurement, 200,000 seconds counting time and a sample volume of about 50000 m^3 [20].

Nuclide	Detection limit	Nuclide	Detection limit
^{7}Be	1.4	^{113}Sn	0.1
^{22}Na	0.2	^{115m}Cd	8
^{24}Na	600 *	^{123m}Te	0.1
^{40}K	7	^{124}Sb	0.4
^{51}Cr	1.6	^{125}Sb	0.4
^{54}Mn	0.1	^{129m}Te	5
^{57}Co	0.1	^{131}I	1.3 **
^{58}Co	0.1	^{132}Te	3
^{59}Fe	0.3	^{134}Cs	0.2
^{60}Co	0.2	^{136}Cs	0.2
^{65}Zn	0.3	^{137}Cs	0.1
^{75}Se	0.2	^{140}Ba	0.6
^{95}Nb	0.2	^{140}La	22
^{95}Zr	0.4	^{141}Ce	0.2
^{99}Mo	20	^{144}Ce	0.7
^{103}Ru	0.1	^{202}Tl	0.3
^{106}Ru	0.9	^{210}Pb	5
^{109}Cd	3	^{237}U	2
^{110m}Ag	0.2		

* Due to the relatively short half-life of ^{24}Na and the long delay between the sampling and the measurement (10 days waiting time), this nuclide cannot be determined on the well-type detector. Therefore, the detection limit for the coaxial detector is given (3 days waiting time, 100,000 seconds counting time).

** Due to the sample preparation procedure the volatile nuclide ^{131}I cannot be determined on the well-type detector. Therefore, the detection limit for the coaxial detector is given (3 days waiting time, 100,000 seconds counting time).

Table B4: Precipitation per month and ^{3}H-, long-lived gross α- and gross β-activity in deposition sampled in 1998 on the RIVM premises in Bilthoven (The Netherlands).*

Month 1998	**Precipitation mm**	**^{3}H Bq·m^{-2}**			**Gross α Bq·m^{-2}**			**Gross β Bq·m^{-2}**		
January	82.2	< 90			1.5	±	0.2	6.2	±	0.5
February	23.7	< 26			2.9	±	0.3	3.6	±	0.3
March	116.7	< 130			2.0	±	0.4	6.7	±	0.5
April	105.0	< 116			1.2	±	0.2	6.7	±	0.5
May	52.0	97	±	20	2.7	±	0.3	7.5	±	0.6
June	193.4	384	±	76	4.4	±	0.5	19.9	±	1.6
July	66.4	145	±	27	5.7	±	0.6	7.7	±	0.6
August	75.3	213	±	30	1.4	±	0.3	4.6	±	0.4
September	141.8	224	±	55	2.9	±	0.4	13.8	±	1.1
October	193	< 328			3.0	±	0.4	14.8	±	1.2
November	112.9	< 192			1.9	±	0.3	8.1	±	0.7
December	75.6	134	±	42	1.7	±	0.3	6.5	±	0.5
Total	1238	1200	±	110	31.1	±	1.3	106	±	3

** The error in the sum is equal to the square root of the sum of the squared monthly errors. Errors are given as 1σ.*

*Table B5: Yearly totals** for gross α– and gross β–activity of long-lived nuclides, ^{3}H, ^{210}Pb and ^{210}Po in deposition for 1983 - 1998 (see also [16-19]).*

Year	Precipitation mm	Gross α Bq·m^{-2}	Gross β Bq·m^{-2}	^{3}H Bq·m^{-2}	$^{210}Pb^{\#}$ Bq·m^{-2}	$^{210}Po^{\#}$ Bq·m^{-2}
1983	869	40	120	2100	-	-
1984	868	25	130	2610	-	-
1985	767	30	140	3800	-	-
1986	825	45	18000	2400	15	3
1987	975	24 ± 1(*)	85 ± 3(*)	2630	52	6
1988	887	36 ± 2	103 ± 3	1700 ± 40	110 ± 3	25 ± 1
1989	706	43 ± 1	89 ± 3	1560 ± 130	94 ± 7	24 ± 4
1990	756	68 ± 1	121 ± 4	1360 ± 120	85 ± 4	16 ± 2
1991	699	48 ± 1	85 ± 1	1060 ± 50	56 ± 1	10 ± 1
1992	946	44 ± 1	87 ± 1	1440 ± 50	83 ± 5	11 ± 1
1993	886	54.3 ± 0.7	87.9 ± 0.8	1310 ± 30	78 ± 3	6.0 ± 0.6
1994	1039	52.0 ± 0.7	91.2 ± 1.0	1210 ± 30	82 ± 3	12.7 ± 0.7
1995	724	39 ± 4	95 ± 8	970 ± 40	(-)[1]	(-)[1]
1996	626	16.4 ± 1.5	67 ± 5	970 ± 50	57 ± 3	9 ± 2
1997	760	23.1 ± 1.3	87 ± 3	1160 ± 60	80 ± 3	< 10
1998	1238	31.1 ± 1.3	106 ± 3	1200 ± 110	91 ± 4	< 16

(*) Introduction of new method. # Data from α-spectroscopy.
- No analysis. (-)[1] Result rejected [20]

** *Errors are given as 1σ.*

Table B6: Quarterly values of ^{210}Pb en ^{210}Po in deposition sampled in 1998 on the RIVM premises in Bilthoven (The Netherlands)*

Period 1998	^{210}Pb Bq·m^{-2}			^{210}Po Bq·m^{-2}
January – March	15.2	±	1.4	< 2.3
April – June	30	±	3	< 5.0
July – September	22	±	2	< 2.6
October - December	24	±	2	4.1 ± 1.1
Total	91	±	4	< 16.2

Measurements are carried out using α-spectroscopy. The error in the sum is equal to the square root of the sum of the squared quarterly errors. Errors are given as 1σ.

Table B7: Weekly values of ^{7}Be, ^{137}Cs and ^{210}Pb deposition sampled in 1998 on the RIVM premises in Bilthoven (The Netherlands).

Week number	Period	Precipitation mm	^{7}Be $Bq \cdot m^{-2}$		^{137}Cs $Bq \cdot m^{-2}$		^{210}Pb $Bq \cdot m^{-2}$	
1	31/12 - 09/01	53.8	47	± 6	0.021	± 0.006	1.4	± 0.2
2	09/01 - 16/01	8.0	4.3	± 0.5			0.32	± 0.05
3	16/01 - 23/01	16.8	34	± 4	0.011	± 0.003	0.90	± 0.14
4	23/01 - 30/01	2.3	13	± 2	0.023	± 0.006	0.41	± 0.08
5	30/01 - 06/02	5.4	3.6	± 0.4	0.011	± 0.003	0.39	± 0.06
6	06/02 - 13/02	2.85	2.3	± 0.3			0.51	± 0.08
7	13/02 - 20/02	0.9	3.2	± 0.4	0.025	± 0.007	0.73	± 0.10
8	20/02 - 27/02	6	3.9	± 0.5			0.47	± 0.07
9	27/02 - 06/03	53.5	49	± 6			2.1	± 0.3
10	06/03 - 13/03	62.8	77	± 9	0.025	± 0.006	3.2	± 0.4
11	13/03 - 20/03	1.4	10.8	± 1.3	0.019	± 0.006	0.63	± 0.10
12	20/03 - 27/03	7.2	3.9	± 0.5			0.57	± 0.08
13	27/03 - 03/04	7.3	8.3	± 1.0	0.017	± 0.004	0.66	± 0.10
14	03/04 - 10/04	36	85	± 10	0.045	± 0.014	3.0	± 0.4
15	10/04 - 17/04	28.5	31	± 4			1.27	± 0.19
16	17/04 - 24/04	8	12.8	± 1.5			0.58	± 0.09
17	24/04 - 29/04	25.5	31	± 4			1.04	± 0.14
18	29/04 - 08/05	6	29	± 4			2.4	± 0.3
19	08/05 - 15/05	0	6.1	± 0.7	0.039	± 0.007	1.32	± 0.17
20	15/05 - 20/05	0	4.2	± 0.5			2.0	± 0.2
21	20/05 - 29/05	46	59	± 7	0.027	± 0.006	5.3	± 0.7
22	29/05 - 05/06	6.5	7.3	± 0.9	0.029	± 0.005	1.07	± 0.15
23	05/06 - 12/06	125.5	180	± 20	0.106	± 0.016	18	± 2
24	12/06 - 19/06	34.7	78	± 9	0.020	± 0.006	8.0	± 1.0
25	19/06 - 26/06	4.9	19	± 2	0.022	± 0.007	2.6	± 0.3
26	26/06 - 03/07	22.1	22	± 3	0.018	± 0.005	2.7	± 0.3

Table B7: Continued.

Week number	Period	Precipitation mm	^{7}Be Bq·m^{-2}			^{137}Cs Bq·m^{-2}			^{210}Pb Bq·m^{-2}		
27	03/07 - 10/07	5.5	19	±	2	0.020	±	0.005	1.7	±	0.2
28	10/07 - 17/07	21	31	±	4	0.020	±	0.006	3.3	±	0.4
29	17/07 - 24/07	10.5	26	±	3				1.6	±	0.2
30	24/07 - 31/07	29	47	±	6				3.7	±	0.5
31	31/07 - 07/08	5.7	15	±	2	0.015	±	0.003	2.8	±	0.3
32	07/08 - 14/08	0	3.5	±	0.4				2.3	±	0.3
33	14/08 - 21/08	1.9	6.4	±	0.8	0.015	±	0.005	1.8	±	0.2
34	21/08 - 28/08	66	87	±	10				7.3	±	0.9
35	28/08 - 04/09	30.2	82	±	10	0.023	±	0.008	8.0	±	1.0
36	04/09 - 11/09	24	43	±	5				7.1	±	0.8
37	11/09 - 18/09	78	130	±	20				13.3	±	1.6
38	18/09 - 25/09	4.3	7.6	±	0.9	0.020	±	0.006	2.9	±	0.4
39	25/09 - 02/10	7	5.9	±	0.7				0.86	±	0.11
40	02/10 - 09/10	28	30	±	4				2.0	±	0.3
41	09/10 - 16/10	24.5	38	±	5				5.6	±	0.7
42	16/10 - 23/10	16.3	22	±	3				2.5	±	0.3
43	23/10 - 30/10	84.5	130	±	15	0.018	±	0.006	8.3	±	1.1
44	30/10 - 06/11	100.3	138	±	16				10.4	±	1.3
45	06/11 - 13/11	23.1	24	±	3				2.5	±	0.3
46	13/11 - 20/11	15.5	46	±	5				5.8	±	0.7
47	20/11 - 27/11	7.1	6.0	±	1.0				1.29	±	0.17
48	27/11 - 04/12	6.5	4.0	±	0.5				0.57	±	0.10
49	04/12 - 11/12	13.2	16.2	±	1.9				1.5	±	0.2
50	11/12 - 18/12	28.5	21	±	2				1.6	±	0.2
51	18/12 - 24/12	14.4	20	±	2				1.00	±	0.16
52	24/12 - 31/12	19.5	20	±	2				1.23	±	0.17
	Sum		1840	±	50	0.600	±	0.030	163	±	4
	SD			40			0.019			4	

Measurements are carried out using γ-spectroscopy. Empty fields indicate that the value was below the detection limit. The error in the sum is equal to the square root of the sum of the squared weekly errors. SD is the standard deviation of the weekly results. Errors are given as 1σ. Empty fields indicate that the value was below the detection limit.

Table B8: Yearly average results and 5- and 95-percentile values in 1998 for α-activity concentration and ambient dose-equivalent rate, as measured by the macro-stations.

Station (nr)	α-Activity concentration Bq.m^{-3}			Ambient dose equivalent rate nSv.h^{-1}		
	5-p	year average	95-p	5-p	year average	95-p
Vredepeel(131)	0.8	3.3	8.8	63	67	71
Wijnandsrade (133)	0.9	4.5	12.3	83	87	91
Houtakker(230)	0.7	3.1	7.9	67	73	76
Huijbergen(235)	0.4	2.9	7.4	66	68	72
Braakman(318)	0.5	3.0	8.1	74	77	80
Vlaardingen(433)	0.4	2.4	6.4	78	81	84
De Zilk(444)	0.3	2.4	7.4	74	78	81
Wieringerwerf(538)	0.1	3.1	6.9	79	82	86
Bilthoven(627)	0.6	2.9	7.8	72	74	78
Biddinghuizen(631)	0.5	2.8	7.8	86	88	92
Wageningen(724)	0.8	3.6	9.3	88	97	95
Witteveen(928)	0.4	2.2	6.1	66	68	70
Kollumerwaard(934)	0.3	2.6	7.3	79	82	85

Table B9: The yearly average results for ambient dose equivalent rate for the different NMR stations

Station	No.	Ambient dose equivalent rate nSv.h^{-1}	Station	No.	Ambient dose equivalent rate nSv.h^{-1}
Den Burg	1001	74	Neede	1138	70
Van Ewijcksluis	1002	69	Enschede	1139	69
Den Oever	1003	73	Losser	1140	67
Julianadorp	1004	68	Oldenzaal	1141	72
Petten	1006	65	Westerhaar	1142	67
Kolhorn	1007	84	Rijssen	1143	68
Egmond aan Zee	1009	68	‘s Heerenberg	1144	83
Heerhugowaard	1011	75	Dinxperlo	1145	81
Haarlem-Noord	1014	76	Varsseveld	1146	72
Nederhorst den Berg	1015	62	Groenlo	1147	84
Enkhuizen	1018	74	Deventer	1148	77
Oosthuizen	1019	69	Heeten	1149	68
Zaandam	1021	70	Lochem	1151	72
Gouda	1024	75	Olst	1152	72
Dordrecht	1027	63	Etten-Leur	1154	71
Zuid-Beijerland	1028	80	Raamsdonkveer	1159	84
Pijnacker	1032	82	Ulvenhout	1160	67
Rotterdam-Crooswijk	1033	75	Baarle-Nassau	1161	94

Table B9: continued

Station	No.	Ambient dose equivalent rate nSv.h^{-1}	Station	No.	Ambient dose equivalent rate nSv.h^{-1}
Rotterdam Waalhaven	1034	73	Uden	1162	72
Maasvlakte	1035	76	Mill	1163	66
Schiedam/Kethel	1036	74	Veghel	1164	65
Maassluis	1037	84	Oploo/Elsendorp	1165	59
Hellevoetsluis	1038	102	Cuyk	1166	82
Ouddorp	1039	67	Oss	1167	71
Ridderkerk	1040	83	Nuenen	1172	73
Wekerom	1041	85	Deurne	1173	70
Wageningen	1043	74	Bergeyk	1174	99
Woudenberg	1045	71	Waalre	1175	70
Hooglanderveen	1046	74	Someren(dorp)	1176	71
Harderwijk	1050	68	Best	1177	66
Wijk Bij Duurstede	1056	83	Oisterwijk	1178	76
Rhenen	1061	79	Riel	1179	68
Nieuwegein	1062	85	Oostelbeers	1180	85
Apeldoorn	1066	71	Hilvarenbeek	1181	69
Heerenveen	1071	66	Venray	1183	63
Oosterwolde	1072	70	Nieuw-Bergen	1184	63
Bergum	1074	69	Sevenum	1185	70
Witwarsum	1076	94	Veldhoven	1186	66
Sneek	1077	74	Reuver	1188	66
Sint Jacobiparochie	1081	78	Nederweert	1189	73
Holwerd	1082	81	Heythuizen	1190	80
Leeuwarden	1085	70	Mariahoop	1191	72
Zwolle-Zuid	1087	74	Stramprooy	1192	66
Steenwijk	1088	73	Arnhem-Oosterbeek	1193	78
Kampen	1090	73	Alphen a/d Rijn	1195	80
Nieuwleusen	1091	64	Leiden	1196	75
Ommen	1093	67	Hulst	1197	73
Hardenberg	1095	69	Terneuzen	1199	80
Assen	1097	66	Sluis	1201	74
Rutten	1099	78	Vlissingen	1202	78
Lelystad	1103	76	Halsteren	1204	67
Urk	1105	78	Oud-Gastel	1206	70
Eemshaven	1106	78	Goes	1207	79
Uithuizen	1107	84	Stavenisse	1208	81
Ten Boer	1108	79	Bruinisse	1209	79
Wagenborgen	1109	73	Burgh-Haamstede	1211	63
Winschoten	1110	73	Vrouwenpolder	1212	66
Ter Apel	1111	69	Wemeldinge	1214	83

Table B9: continued

Station	No.	Ambient dose equivalent rate nSv.h^{-1}	Station	No.	Ambient dose equivalent rate nSv.h^{-1}
Stadskannaal	1112	65	Middelburg	1215	76
Nieuweschans	1113	70	Westkapelle	1216	71
Bellingwolde	1114	62	Noordwijk-Binnen	1217	73
Groningen	1116	78	Stein	1219	82
Leens	1117	79	Maastricht	1220	89
Grijpskerk	1118	72	Ravensbos	1221	91
Roden	1120	64	Vaals	1222	86
Winsum (gr))	1121	72	Gulpen	1223	77
Norg	1122	69	Kerkrade	1224	89
Meppel	1125	65	Hoensbroek	1225	87
Hoogeveen	1126	66	Wijchen	1226	80
Steenwijksmoer	1129	71	Gennep	1228	74
Nieuw-Amsterdam	1130	73	Elst (gld)	1229	89
Nw. Schoonebeek/Weiteveen	1131	65	Zevenaar	1230	83
Emmen	1132	70	Nijmegen	1231	69
Borne	1135	70	Amstelveen	1233	79
Hengelo (gld)	1136	74	Amsterdam-Oost	1234	74
Ruurlo	1137	72	Aalsmeer	1236	78

Table B 10: Radioactivity in surface water (mBq·L^{-1}) as measured by RIZA.

Location: Eijsden (Meuse)		
Date	**Tritium**	**Residual β**
27-1-98	1800	29
24-2-98	62300	36
24-3-98	4700	18
21-4-98	2800	55
19-5-98	3900	14
16-6-98	2200	61
14-7-98	2300	5
11-8-98	3300	41
8-9-98	38100	32
6-10-98	9400	30
3-11-98	1700	110
1-12-98	1800	30
29-12-98	1800	50
Average	***10500***	***39***
Location: Lobith (Rhine)		
Date	**Tritium**	**Residual β**
28-1-98	5300	57
25-2-98	5800	36
25-3-98	2900	57
22-4-98	7500	30
18-5-98	7700	41
17-6-98	6000	38
15-7-98	7900	24
12-8-98	4200	36
9-9-98	4200	29
7-10-98	4600	53
4-11-98	2600	140
2-12-98	2600	69
28-12-98	4000	25
Average	***5000***	***49***
Location: Schaar van Ouden Doel (Scheldt)		
Date	**Tritium**	**Residual β**
6-1-98		120
2-2-98	7600	89
2-3-98		150
30-3-98	7300	68
27-4-98		82
25-5-98	18900	52
29-6-98		60
27-7-98	10800	73
24-8-98		74
28-9-98	6300	56
26-10-98		68
23-11-98	8700	96
21-12-98		78
Average	***9900***	***82***

Table B 11: Radioactivity in suspended solids (Bq·kg^{-1}) as measured by RIZA.

Location: Eijsden (Meuse)	
Date	**Cs-137**
6-1-98	20
13-1-98	20
20-1-98	20
27-1-98	20
2-2-98	19
9-2-98	6
16-2-98	14
23-2-98	15
2-3-98	22
10-3-98	19
16-3-98	30
24-3-98	22
30-3-98	18
7-4-98	21
14-4-98	20
21-4-98	16
28-4-98	19
6-5-98	21
12-5-98	15
19-5-98	14
26-5-98	18
2-6-98	18
9-6-98	17
16-6-98	19
23-6-98	16
30-6-98	19
7-7-98	18
14-7-98	19
21-7-98	18
28-7-98	15
4-8-98	19
11-8-98	10
18-8-98	17
25-8-98	16
1-9-98	15
8-9-98	20
15-9-98	8
22-9-98	23
29-9-98	8
6-10-98	22
13-10-98	21
20-10-98	27
27-10-98	17
3-11-98	19
10-11-98	24
17-11-98	18
24-11-98	18
1-12-98	13
8-12-98	16
15-12-98	16
29-12-98	16
Average	***18***

Location: Ketelmeer-West	
Date	**Cs-137**
9-1-98	24
3-2-98	28
3-4-98	27
23-7-98	24
18-9-98	27
13-11-98	33
Average	***27***
Location: Lobith (Rhine)	
Date	**Cs-137**
28-1-98	26
25-2-98	18
25-3-98	24
22-4-98	25
18-5-98	21
17-6-98	24
15-7-98	22
12-8-98	18
14-9-98	18
7-10-98	24
4-11-98	25
2-12-98	20
30-12-98	24
Average	***22***
Location: Schaar van Ouden Doel (Scheldt)	
Date	**Cs-137**
06-01-98	17
02-02-98	15
02-03-98	17
30-03-98	15
27-04-98	17
27-05-98	16
30-06-98	14
29-07-98	
25-08-98	13
29-09-98	15
26-10-98	13
23-11-98	15
21-12-98	17
Average	***15***

Table B 12: Radioactivity in seawater ($mBq \cdot L^{-1}$) as measured by RIZA.

Location: Noordwijk 10		
Date	**Tritium**	**Residual β**
12-1-98	3800	43
9-2-98	5300	33
16-4-98	6100	46
27-5-98	4700	46
18-6-98	3600	46
16-7-98	4100	47
13-8-98	4500	33
3-9-98	4700	56
12-11-98	4900	48
16-12-98	6900	47
Average	***4860***	***45***

Location: Noordwijk 70		
Date	**Tritium**	**Residual β**
10-2-98	2100	49
16-4-98	3000	28
27-5-98	800	45
16-7-98	3000	50
13-8-98	3900	51
12-11-98	5200	35
Average	***3000***	***43***

Location: Terschelling 235		
Date	**Tritium**	**Residual β**
18-2-98	300	53
21-4-98	200	24
26-5-98	1600	43
29-7-98	25	57
11-8-98	800	23
18-11-98	400	57
Average	***600***	***44***

APPENDIX C

MAILING LIST

1	-	30	Regionaal Inspecteur MilieuHygiëne Zuid-West
31	-	44	Directie Stoffen, Veiligheid, Straling
45			Hoofdinspectie MilieuHygiëne, Afdeling Crisismanagement
46			plv. Directeur-Generaal Milieubeheer
48	-	68	Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling
69	-	79	Rijksinstituut voor Kust en Zee
80	-	85	Inspectie W & V
86			Hoofdinspecteur W & V.
87	-	90	Inspectie W & V Oost
91			Directeur Inspectie W&V Oost
92			Hoofd Signalering Veterinaire Producten InspectieW & V Oost
93			Depot van Nederlandse publicaties en Nederlandse bibliografie
94			Directie RIVM
95			Directeur Sector Stoffen en risico's
96			Hoofd van het Laboratorium voor Stralingsonderzoek
97			Hoofd van de afdeling Monitoring en Meetmethoden van het Laboratorium voor Stralingsonderzoek
98			Hoofd van de afdeling Modellen en Processen van het Laboratorium voor Stralingsonderzoek
99			Hoofd van de afdeling Kwaliteit van het Laboratorium voor Stralingsonderzoek
100			Auteur
101			SBD/Voorlichting & Public Relations
102			Bureau Rapportenregistratie
103			Bibliotheek RIVM
104	-	140	Bureau Rapportenbeheer
141	-	165	Reserve exemplaren ten behoeve van het Laboratorium voor Stralingsonderzoek