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AIRBORNE RADIOACTIVITY IN FINLAND AFTER THE CHERNOBYL ACCIDENT IN 1986

Supplement 1 to Annual Report STUK-A55

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Helsinki, Finland

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ABSTRACT

In the air surveillance programme of the Finnish Centre for Radiation and Nuclear Safety concentrations of artificial radionuclides are monitored in the air close to the ground. Airborne dust is collected continuously on a glass fibre filter by a high-volume air sampler at Nurmijärvi, 40 km north of Helsinki, and the concentrations of radionuclides are evaluated. Extensive studies on radionuclide composition in air and spatial distribution were performed in Finland after the Chernobyl accident. The fallout situation was followed by temporary air sampling in Helsinki and Rovaniemi, with short sampling periods and also with air dust samples from the upper atmosphere. In Nurmijärvi, air samples were also taken on an activated carbon bed. All samples were measured by gammaspectrometry, but some radiochemical analyses were also performed.

Fallout from Chernobyl arrived in Finland on Sunday, April 27. The maximum concentrations in air were measured on Monday evening, April 28, and ranged from a few microbecquerels to two hundred becquerels per cubic metre. At an altitude of about 1500 m the concentrations of radionuclides were even two decades higher. The radionuclide concentrations in air decreased rapidly being under one hundredth part of their maximum values after few days.

CONTENTS

1 INTRODUCTION

Artificial radionuclides in airborne dust at ground level have been routinely monitored in the air surveillance programme of the Finnish Centre for Radiation and Nuclear Safety (STUK) since 1968. The aim of the programme is to monitor continuously the concentrations of artificial radionuclides in the air in Nurmijärvi, 40 km north of Helsinki. The air sample is collected on a glass fibre filter and analysed by gammaspectrometry.

On Monday, April 28, when indications of an abnormal radiation situation were noticed in Finland, the filter from Nurmijärvi was taken to Helsinki at 3 p.m. and analysed at once. It was immediately clear that unusual high concentrations of fresh fission products were present in the air. The existence of very short-lived nuclides and peculiar nuclide ratios (e.g. the ratio of ^{95}Zr to ^{95}Nb compared to fresh debris from nuclear test explosions) as well as the high concentration of ^{134}Cs in the sample strongly indicated an accident in a nuclear power plant.

Extensive studies of the fallout were started immediately. The temporal and spatial distribution of the debris and its composition was followed by changing the air collection period from three and four days to a few hours, and portable samplers were put into operation in Helsinki and Rovaniemi. The occurence of iodine in forms other than particulate ones was noticed, and a cartridge containing activated carbon was assembled in the sampling device at Nurmijärvi. Information on the radioactive cloud distribution over Finland and its concentration was studied with flight filter samples taken by the Defence Forces and analysed at the STUK. The levels of external gamma radiation were measured continuously during flights.

Particles with enhanced radioactive materials were soon found in the environment. These hot particles were also discovered in air filter samples; they were identified by using the autoradiographical method, and were measured by gammaspectrometry.

This report describes the air dust sampling and analysing methods and presents the results obtained in 1986 after the Chernobyl accident. The activity concentrations were evaluated by gammaspectrometry; from some air samples with high activity also the transuranic elements were separated radiochemically and measured with alphaspectrometry. The results of strontium analyses will be published later. The radionuclide concentrations in air around the Finnish nuclear power plants and airborne ^{14}C and ^{3}H in Helsinki are published elsewhere [3,11]. The calculated dose equivalent through inhalation as well as the total dose to the Finnish population resulting from the Chernobyl accident in 1986 will be published later [17].

2 SAMPLING AND ANALYSING METHODS

2.1 Airborne dust sampling at ground level

In Nurmijärvi, 40 km north of Helsinki, airborne dust is collected on a glass fibre filter. The filter is changed every Monday and Thursday, and sometimes more often under exceptional conditions. From Monday, April 28, the filters were changed twice a day for several days. Later, as the radioactivity in air dropped, the sampling frequency was gradually decreased, until in June the filters were again being changed twice a week. Air sampling on activated carbon was also started on April 29.

The high-volume air sampler located in Nurmijärvi was constructed at the STUK together with the Technical Research Centre of Finland [6]. It consists of a compressor type pump and filter holders for a glass fibre filter and an activated carbon cartridge. The air inlet construction allows particles of less than approximately 50 µm to reach the filter surface. To prevent the recirculation of the filtered air, a 6 metre metal duct is connected to the exhaust end of the sampler. The compressor type pump gives an excellent high suction pressure and a constant air flow rate that is nearly independent of the resistance of the filter. Air is sucked through a glass fibre filter at the rate of 750 m^3/h; the rate can be increased up to 1100 m^3/h. The corresponding face velocities are 0.9 m/s and 1.4 m/s, respectively. The filter area is 0.22 m^2.

The air flow rate through the filter and the carbon bed is calculated from the pressure difference over a calibrated flange. This pressure difference also forces some of the air passed through the filter to flow through the cartridge containing activated carbon. The air flow rate through the carbon bed is 12 m^3/h. To ensure a very high iodine retention even in the form of methyl iodide, the residence time in the carbon bed is 0.17 s, the face velocity 0.4 m/s.

Particles are collected on a Whatman glass fibre filter, type

GF/A* . Activated carbon impregnated with potassium iodide, type 207B-1.5 KI 8 - 12 mesh** , is used in the cartridge.

Air sampling was started in Konala, in a northwest district of Helsinki, on Monday of April 28. A portable sampler with an air flow rate of about 150 m^3 per hour was used [1]. The sampling period at the beginning was one to two hours, but during the summer it was gradually increased to one week. In northern Finland, in Rovaniemi, airborne dust sampling was started on May 6, using a portable sampler (STAPLEX***) with a capacity of about 100 m^3 per hour. Only glass fibre filters were used in these samplers.

2.2 Studies of radioactivity at higher altitudes

Samples of particulate radioactivity at higher altitudes are taken with a filtering pod mounted on an aircraft. Particles are collected on a Whatman glass fibre filter, type GF/A. The nominal air flow rate through the filter is 2.7 m^3 per minute, corresponding to a face velocity of 0.2 m/s. Filters are analysed by gammaspectrometry in the STUK laboratory. The levels of external gamma radiation are measured continuously during flights. Thus the distribution can also be monitored directly.

The measurements of radioactivity were started on April 28. Thereafter, monitoring and sampling were carried out whenever there was reason to believe that approaching air masses could contain radioactive substances.

2.3 Gammaspectrometric analyses

After sampling, the glass fibre filters are pulverized by compressing; the powder is homogenized and repressed onto

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* Whatman Ltd, Maidstone, ENGLAND
** Sutcliffe Speakman Ltd, Leigh - Lancanshire, ENGLAND
*** Staplex Co, New York, USA

discs to provide a suitable counting geometry for gamma-spectrometric analysis. There are eight spectrometry systems in the laboratory. The relative efficiency of the detectors, whether lithium drifted crystals or high purity ones, varies between 15% and 39%. Activated carbon is measured without any pre-treatment in a Marinelli beaker (0.5 litre). The detectors are placed in background shields made of 12-14 cm thick lead rings which are gradually lined with cadmium (1 mm) and copper (0.5 mm) to reduce the effect of X-rays. For a few months after the accident, the background shields were also ventilated with aged pressurized air in order to minimize the background. Calibration of the detectors and calculation of activity concentrations by the computer are described elsewhere [14,15] .

2.4 Hot particles

After the gammaspectrometric measurements, the first three air dust samples, collected in Nurmijärvi just after the fallout had reached Finland, were prepared to detect the presence of hot particles. Part of each pulverized filter was spread on self-adhesive plastic foils, and the autoradiography method was used to locate spots with higher activity on the foils. Ten of those spots within a surrounding area of 0.95 cm^2 were cut off for gammaspectrometric measurements. Areas the same size with no visible spots were also cut off from every foil, in order to measure the 'background concentrations' of the samples. The films were exposed for 24 hours. The spots were measured in May, 1987; thus only longer-lived nuclides could be detected.

2.5 Analyses of transuranic elements

The analysing method used in routine monitoring of plutonium and americium [18] was modified for measurements of transuranic elements in the air filter samples taken after the Chernobyl accident. Homogenized air filter samples of 1 - 1.5 grammes were digested and leached with nitric acid and a mixture of

nitric and hydrochloric acids. Plutonium isotopes were then separated by using the anion exchange technique. Americium and curium fractions were first co-precipitated with oxalate and ferric hydroxide and passed through several ion exchange columns. The final purification was made with anion exchange by washing with ammoniumrodanide solution and eluating americium and curium together with diluted hydrochloric acid and methancl.

After electrodeposition onto stainless steel discs, the alpha activity was measured with silicon surface barrier detectors and a multichannel pulse height analyser. The measuring time varied from 2000 to 5000 minutes.

Internal tracers of ^{242}Pu and ^{243}Am were used for yield determinations. Parallel analyses without tracers were made to evaluate the amounts of ^{242}Pu and ^{243}Am in samples. The concentrations of those nuclides were then calculated from the nuclide ratios in parallel analysis. The amounts of ^{242}Pu and ^{243}Am were, however, so small that they did not affect the yield determination with tracers. Recoveries varied from 50% to 100%.

3 RESULTS

3.1 Ground-level air

The radionuclide concentrations in ground-level air in Nurmijärvi, Helsinki and Rovaniemi are given in Tables I-III. The iodine results for Nurmijärvi are the sums of particulate and gaseous forms of iodine nuclides, whereas for Helsinki and Rovaniemi only the aerosol concentrations of iodine are given. The carbon cartridge was not assembled in the sampler during the first four collection periods. For similarity reasons, however, the values of iodine nuclides for these periods are corrected by using the 85% penetration measured later. The activity concentrations are calculated to the median of the sampling period.

The error in evaluation of the air volume through the sampler is estimated to be 5% in Nurmijärvi, whereas in Helsinki and Rovaniemi it is 10 - 15%. The statistical error in gamma-spectrometric measurements as well as the minimum detectable activities varied greatly from sample to sample, and were caused by the available measuring time and the nuclide composition in different samples. In some samples a high counting rate, due to high radioactivity also increased the analysing error. To avoid this some samples had to be divided into pieces. The total error, including errors in counting, calibration and air volume, is 5 - 10% (relative standard deviation) for the strongest peaks in the spectrum. The number of significant digits in the tables reflects the total error of the analysis.

The air sample collected from April 24 to April 28 according to the routine programme clearly shows the arrival of fresh fission products to Finland. The long sampling time made it impossible to evaluate the exact arrival time, but with the help of air surveillance programme carried out by the Finnish Meteorological Institute, the time of arrival in Nurmijärvi was estimated to be April 27 at 3 p.m. [8]. The nuclide concentrations in this sample are calculated to the midpoint

of the time period between the estimated time the debris arrived and the end of the sampling. The results are also corrected by the respective air volume. The high iodine concentrations in the sample, as compared with other nuclides, show the early arrival of iodine to Finland.

To study the composition of the fallout in detail, the sample with the highest concentration collected between 3.10 p.m. and 10.10 p.m. on April 28 was measured several times, at intervals of a few days. In July, when all short-lived nuclides had decayed and the cesium isotopes were dominant in this sample, the cesium was removed chemically. The glass fibre filter was decomposed by $NaOH/Na_2CO_3$ fusion. After adding the carriers, the elements with valency states of +2 and +3 were precipitated as carbonates. The supernatant contained cesium isotopes [16]. The precipitation was measured with a gammaspectrometer; besides the results shown in Table I, 15 mBq/m^3 of ^{54}Mn, 230 mBq/m^3 of ^{127m}Te, 1.3 mBq/m^3 of ^{154}Eu and 0.65 mBq/m^3 of ^{155}Eu were also detected.

The temporal variations of ^{131}I and ^{137}Cs in Nurmijärvi are shown in Figures 1 and 2. The strong variation in concentrations and their time dependence during the first 48 hours is clearly seen in Figures 3 and 4. The variation was caused by the prevailing weather conditions at the time [12] and the interchange of air masses between the radioactive cloud and ground level. The maximum concentrations were observed in the evening of April 28 in Nurmijärvi, and even more clearly in Helsinki between 9 p.m. and 10 p.m. The radionuclide concentrations in air stabilized and declined rapidly because of the change in weather conditions in Finland and because the direct transport of air masses from Chernobyl to Finland ceased on April 29.

The ratios of various nuclides to ^{137}Cs are shown in Figure 5. The ratios are calculated from the concentrations corrected to the time of the accident by taking into account the decay of the nuclides. The ratios of refractive nuclides, zirconium and cerium, coincide well throughout the year (Fig. 5a and 5b). The peaks in ratios indicate hot particles, e.g. uranium

fragments enhanced with these nuclides [10]. Because the ratios are so similar, it can be assumed that both nuclides are combined with the same fragments.

The results of deposition and the prevailing weather conditions indicate that the fallout spread only over southern and central Finland in the first days after the accident [12,13]. In those days the ratio of ruthenium to cesium is clearly lower than after May 10, when a new transport of air masses from Chernobyl reached Finland and spread over the whole country. This is in good agreement with the fact that the ratio of ruthenium to cesium in environmental samples is greater in northern and eastern parts of Finland [9]. The behaviour of ruthenium is not so clear when the ratio of ruthenium is compared with that of other nuclides (Fig. 5c). Some peaks in the ratio of ruthenium to cesium coincide temporally with those of zirconium and cerium after May, but the ratios are different. In May ruthenium behaved like volatile nuclides, e.g. iodine and tellurium. This behaviour can be explained by the fact that ruthenium evaporates easily in oxidizing conditions.

The ratios of molybdenum, barium and tellurium to cesium show that these nuclides behave similarly. The ratio of long-lived ^{129m}Te shows, on average, an increase in concentrations during the year when compared with cesium (Fig. 5d).

The calculated ratio of aerosol iodine to cesium varies strongly from sample to sample, indicating that most of the iodine detected is in a form other than cesium iodide (Fig. 5e). In all the ratios mentioned above, the magnitude of variation is greater than the variation caused by the measurement error.

In the beginning of December, exceptionally high concentrations of cesium and also higher values of antimony and silver were detected in Nurmijärvi. The increase of these nuclides was also observed around nuclear power plants at Loviisa and Olkiluoto [3]. The activity ratios of these nuclides are the same as those in the Chernobyl fallout. The most probable source is

resuspension from the environment, associated with the weather conditions prevalent at the time. The resuspension could partly be from the inlet channels of the sampler, though the wiping samples from the inner surfaces of the sampler did not yield results which alone would explain the observation. The first heavy snowfalls in Finland occured in the beginning of December, and the snowflakes could have caused the desorption of the nuclides in question.

3.2 Iodine

The analyses of activated carbon gives an unexpectedly high penetration of iodine isotopes through particulate filter (Table IV). In carbon no other nuclides were detected by gammaspectrometry. To control the measured high penetration, a glass fibre filter and an activated carbon cartridge were superimposed upon each other in the portable sampler (RADECO*), which allows the same amount of air to be sucked through the filter and the carbon cartridge. The penetration of iodine was the same as that found for Nurmijärvi at the same time. The contamination of the activated carbon used in the sampling was examined with control samples. No contamination was found. Lower iodine penetration has also been measured around nuclear power plants at Loviisa and Olkiluoto [3]. In these samplers glass fibre and carbon-impregnated glass fibre filters are superimposed upon each other. The difference in penetrations can be explained by the lower retention efficiency of carbon-impregnated filter for the gaseous form of iodine, e.g. methyl iodide.

The high penetration of iodine is due to the fact that most of the iodine was in gaseous or desorbable form. The small but significant increase in penetration during the summer shows that the proportion of particulate iodine in the total concentration decreased. Iodine was also detected in a different

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* Science Applications Inc., San Diego, USA

form than the other nuclides by measuring aerosol-size distribution with multijet compressible flow low-pressure impactors [4].

3.3 Transuranic elements

The results of transuranic analyses are given in Tables V and VI. The highest concentrations for Nurmijärvi were detected in the sample collected in the evening, April 28, whereafter the amounts decreased quickly. The prominent alpha-emitting transuranic nuclide was ^{242}Cm. Besides the results shown in Table V, small amounts of ^{236}Pu were detected in some samples, the maximum concentration being 0.32 $\mu Bq/m^3$.

The amounts of transuranic elements in ground-level air were small compared with those of other nuclides. The concentrations of $^{239,240}Pu$ and ^{242}Cm, as compared with the corresponding values of ^{137}Cs, varied from 0.0002% to 0.05% and 0.004% to 0.44%, respectively.

The large variations in the nuclide ratios in air samples, of both the same and different elements, are related to the elements of the fuel, which have different burn-up. The ratio of ^{238}Pu to $^{239,240}Pu$ varied between 0.051 and 1.2. The average was 0.62. Also the ratio of ^{242}Cm to $^{239,240}Pu$ varied greatly, from 0.56 to 110, the average being 19.

As to air filters sampled in Helsinki, transuranic elements were analysed only from some samples collected between April 29 and May 1 (Table VI). Only a few americium and curium analyses were performed.

3.4 High altitude air samples

The concentrations of various radionuclides in high altitude air samples between April 28 and May 11 are presented in Table VII.

The radioactive cloud was first detected in the evening of April 28. The level of external radiation at the altitude of 1300-1500 metres between Helsinki and Turku was above normal for the entire distance. The lateral center of the cloud at that altitude was located 70 km west of Helsinki, and the dose rate was 0.6 μSv/h.

In the afternoon of April 29, the cloud was examined in detail by direct measurements and by taking an air filter sample. The profile of the flight is shown in Figure 6. The gamma radiation levels measured are also given in the same figure. The cloud was not distributed uniformly in the lateral direction in southwest Finland. No concentrated radioactive cloud was observed over southeast Finland.

A more detailed presentation of the vertical shape of the cloud is shown in Figure 7. The values of direct gamma-field measurements are indicated by circles. The dose rate is measured in units of μR/h, and the results are presented in units of μSv/h. A conversion formula of 1 μR/h = 0.01 μSv/h was used. The vertical distribution of the radioactivity concentration is estimated by assuming that the cloud was formed of thin, infinite lateral layers [7]. The photon energy of 0.5 MeV is used in calculation. The calculated values are shown by a solid line. The concentrations are scaled to correspond to the gamma flux of the air sample taken on April 29 (Table VII). The radioactive substances were concentrated between the altitude of 600-3000 metres with the maximum at an altitude of 1500 m above land and 800 m above sea. The thickness of the cloud varied from 500 metres to more than 2000 metres. The cloud was observed to increase in thickness as it passed to the northeast. The effect of rain can be seen in Figures 6 and 7d.

The flight in the morning of April 30, along the same route as in the previous day, revealed that there was no detectable radioactive cloud at a higher altitude, and the air samples showed that the concentrations of radioactive materials at higher altitudes were of the same order of magnitude as in the ground-

level air.

A slight increase in radionuclide concentrations was detected, especially on May 9 at higher altitudes, when a new transport of air masses occured directly from the accident region. Corresponding concentrations of radionuclides were not detected in ground-level air. Thus an advection of radioactive substances in slightly concentrated clouds was observed at the higher altitudes two weeks after the accident.

3.5 Hot particles

Analyses of the hot particles of the three air dust samples collected on April 27 - 29 show that most of the spots contain enhanced amounts of ^{95}Zr, ^{106}Ru and ^{144}Ce (Table VIII). The shorter-lived isotopes, ^{103}Ru and ^{141}Ce, had already decayed before the measurements. The presence of hot particles, e.g. small fragments of the uranium fuel of the damaged reactor [10], has been shown earlier [2,5]. The amount of uranium in these particles was, however, so small that it could not be measured directly with gammaspectrometers. Two of the measured particles also contained an enhanced amount of cesium in addition of ruthenium and cerium.

The numbers of clearly visible spots on films were counted. The corresponding numbers of hot particles in 1000 m^3 at ground level in Nurmijärvi were: 19 particles per 1000 m^3 from Sunday afternoon of April 27 to Monday morning, 76 in Monday morning and 80 particles in Monday afternoon and evening. These figures coincide with those measured by the Finnish Meteorological Institute at the same place in Nurmijärvi [8].

4 CONCLUSIONS

The first direct transport of air masses from Chernobyl to Finland occurred between Sunday of April 27 and Tuesday of April 29. The cloud of radioactive materials observed in Finland resulted from release into the atmosphere at the site of the accident on April 26 [12]. The radioactive debris was found to be concentrated at an altitude of 1300 - 1500 m above southwest Finland. The concentrations of radionuclides in the cloud were as much as a hundred times greater than at ground level on April 28 and 29. The results for Nurmijärvi are the same as those for Helsinki. Cleaner air slowly spread into Finland from the northwest, and on April 30 no concentrated cloud was detected in the upper air. The concentrations of radionuclides at higher altitudes were of the same order of magnitude as in ground-level air.

The second direct transport of air masses from the Chernobyl area to Finland occurred between May 10 and 12. These air masses left the site of the accident between May 7 and 8 [12]. A slight rise in radioactivity was detected in the upper air, especially above the Baltic Sea, on May 9. A lesser increase in radionuclide concentrations was also observed in ground-level air. The radionuclide concentrations were the same in Helsinki, Nurmijärvi and Rovaniemi when the weather conditions at that time are taken into account.

More than 30 fission and activation products were identified from air filter samples. The concentrations of nuclides varied from a few microbecquerels to two hundred becquerels per cubic metre in ground-level air. The most dominant nuclides in the Chernobyl fallout were volatile ones: iodine, tellurium and cesium. The concentrations of refractive transuranic elements were very low.

The first sample containing fallout from Chernobyl and collected on April 24 and in the morning of April 28, shows the early arrival of volatile nuclides, iodine in particular, but it does not contain as many hot particles as the following samples.

Up to 80 hot particles with radioactivity of a few becquerels, were found in 1000 cubic metres of air. The maximum number of hot particles per cubic metre coincided with the maximum concentration of radionuclides measured on April 28. The presence of these particles was also seen in nuclide ratios throughout the year.

The ratios of nuclides vary greatly. The temporal change in ratios, e.g. those of ruthenium and tellurium to cesium, is associated with the oxidizing conditions in the fire of the reactor and also with their behaviour in the atmosphere. Hot particles also cause larger peaks in ratios as well as an increase in concentrations. Large variation in ratios, both those of the same element and of different elements, refractive transurans in particular, are related to their origin from fuel rods with different burn-up.

The penetration of iodine through the glass fibre filter to the carbon bed shows that most of the iodine in air was in gaseous or desorbable form. The penetration varied between 85% and 95%. The results show the necessity of iodine sampling on a carbon bed together with particle collection on filters.

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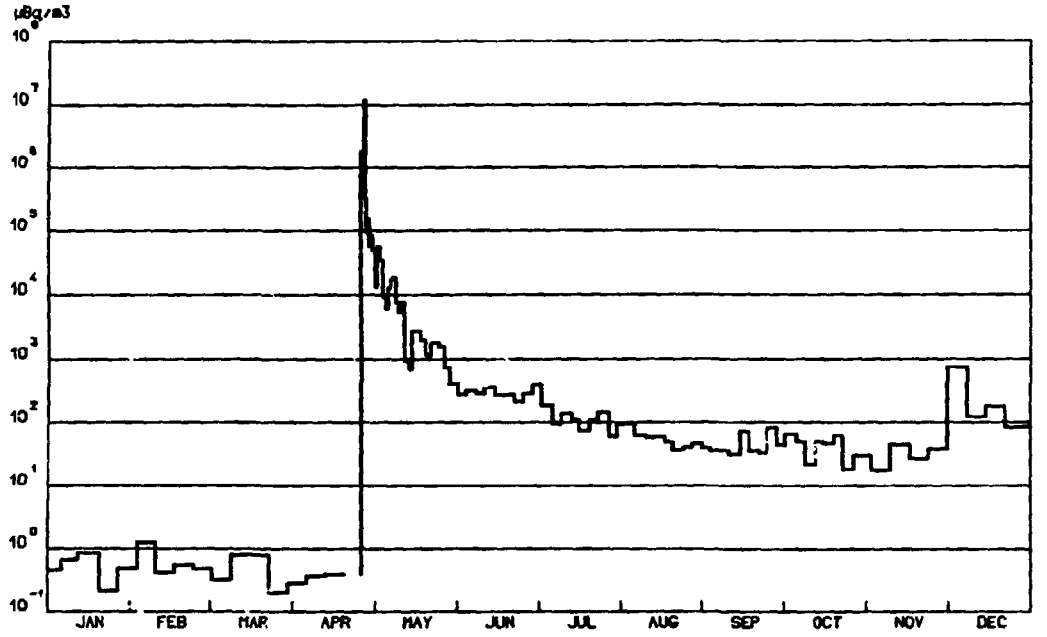

Fig. 1 Variation of ^{137}Cs concentration in ground-level air in Nurmijärvi in 1986.

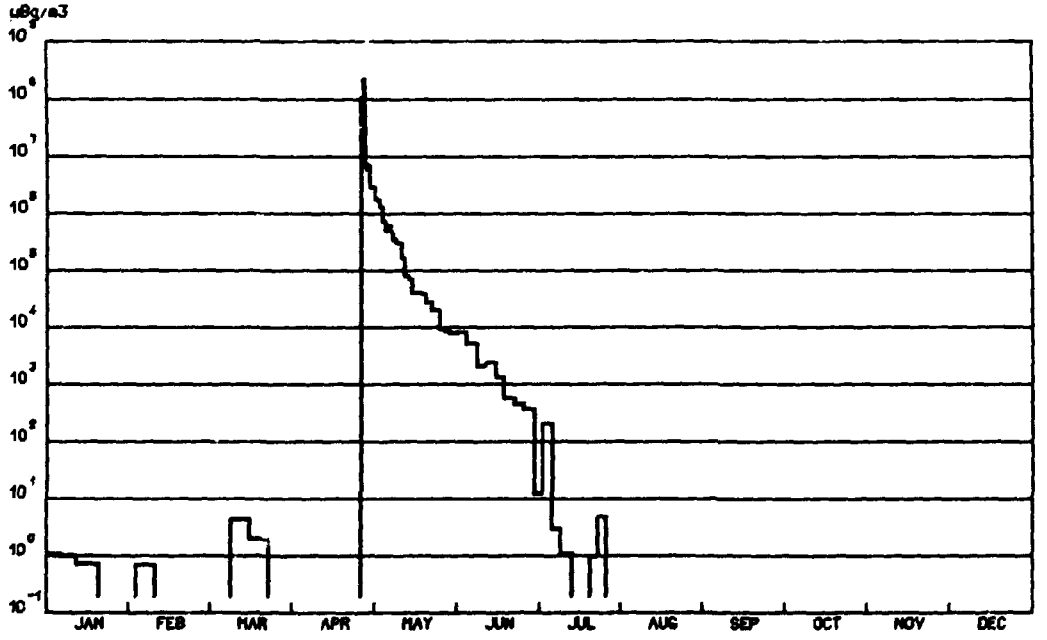

Fig. 2 Variation of ^{131}I concentration in ground-level air in Nurmijärvi in 1986.

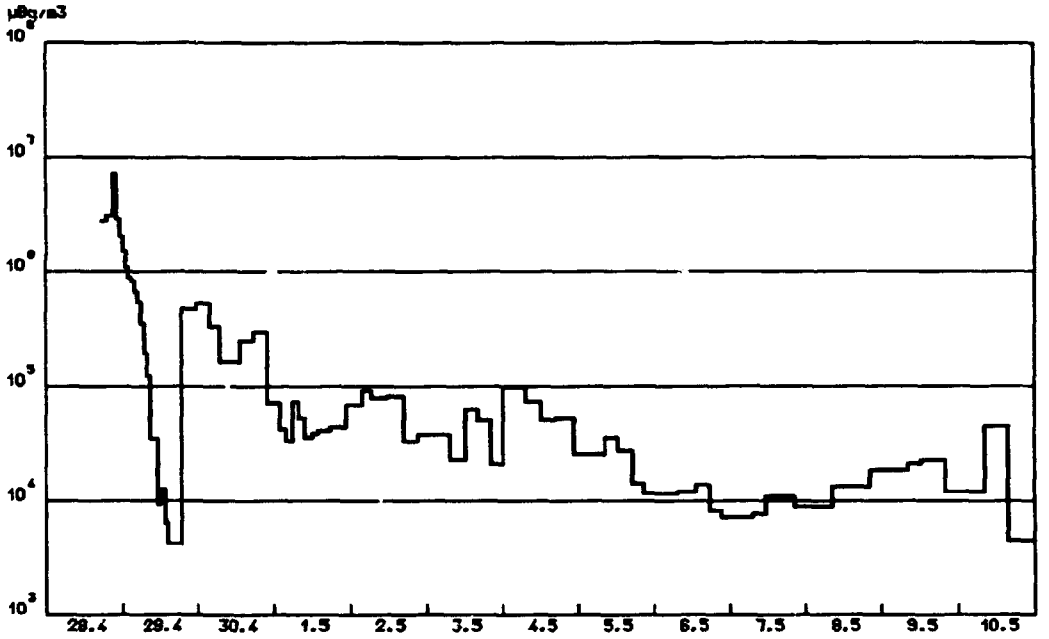

Fig. 3 Variation of ^{137}Cs concentration in ground-level air in Helsinki from April 28 to May 10, in 1986.

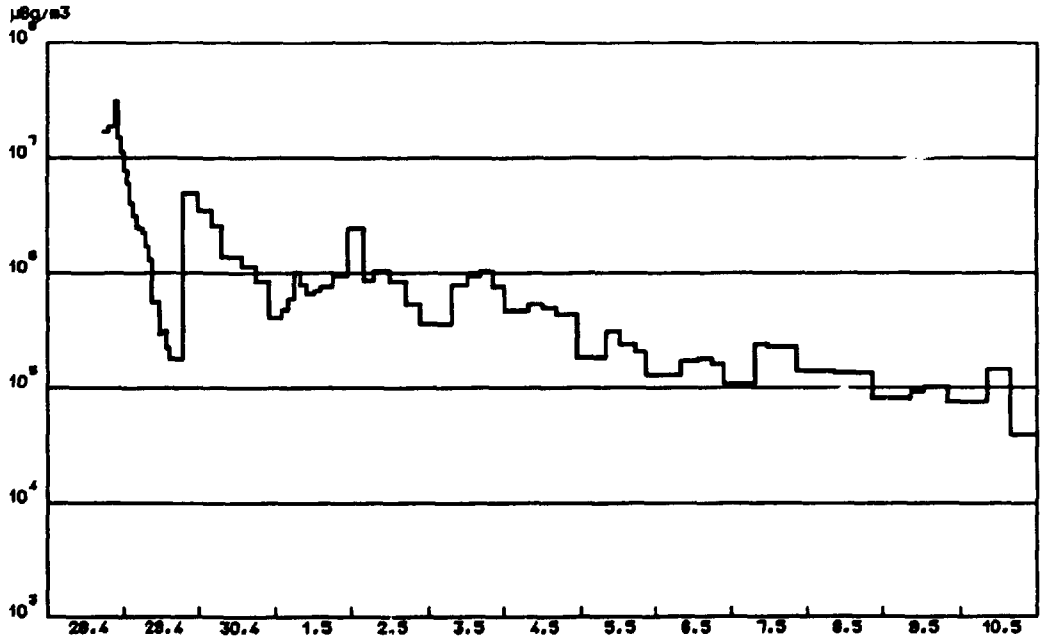

Fig. 4 Variation of ^{131}I concentration in ground-level air in Helsinki from April 28 to May 10, in 1986.

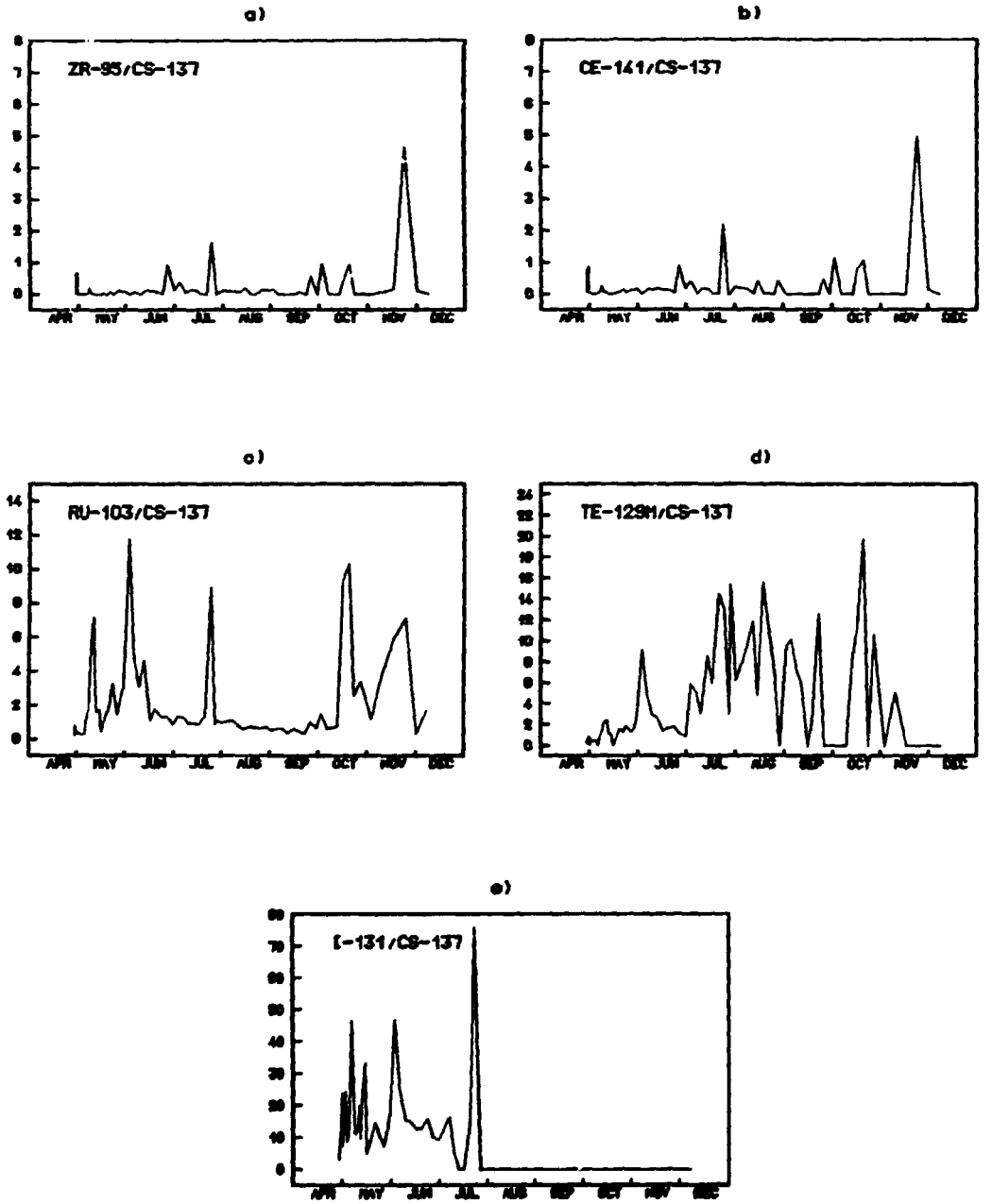

Fig. 5 Ratio of various nuclides to ^{137}Cs in ground-level air in Nurmijärvi in 1986.

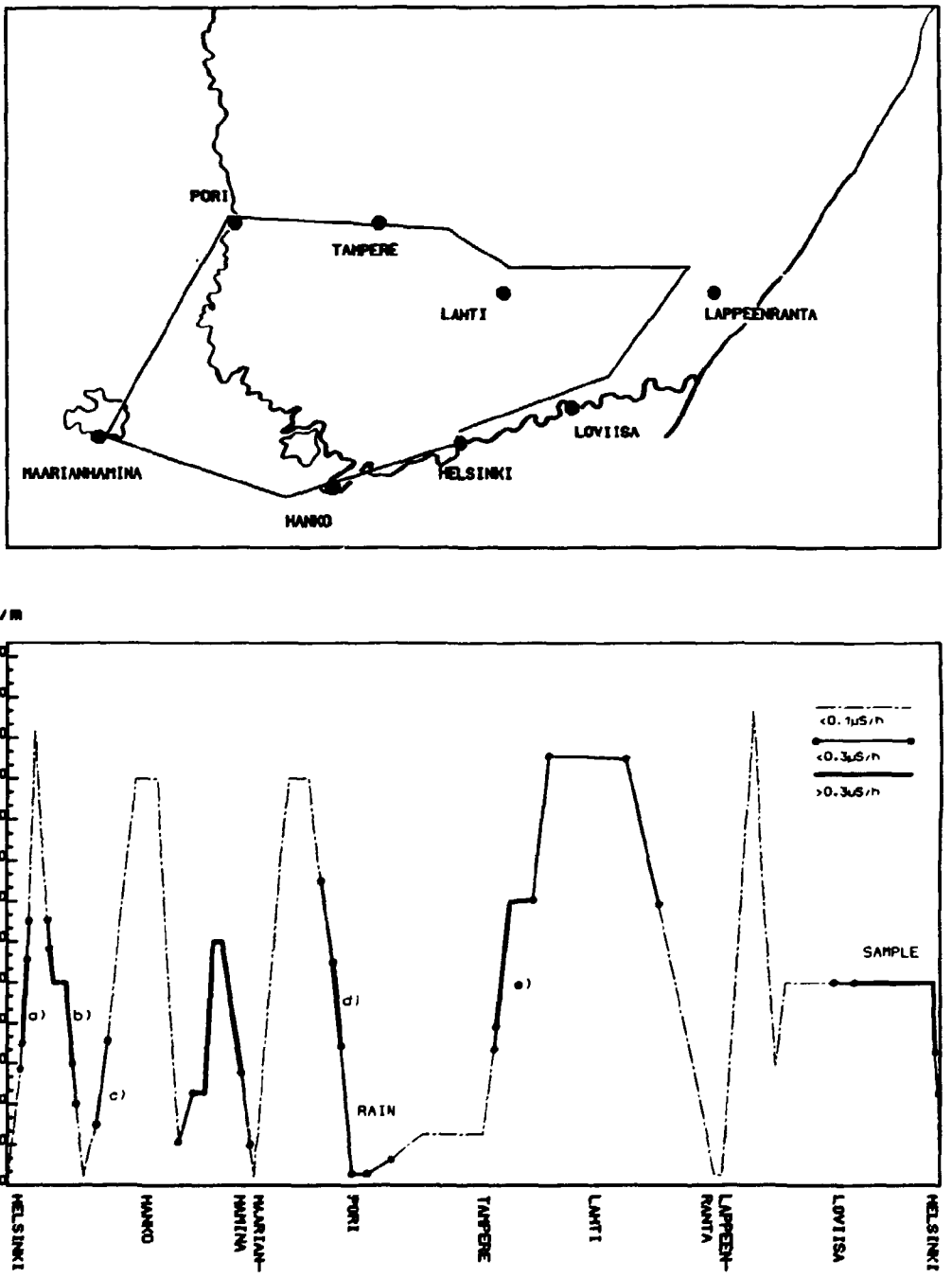

Fig. 6 Route and profile of the flight over southern Finland at 1 - 3 p.m. on April 29, 1986. The cloud distribution is shown in Figure 7a-7e.

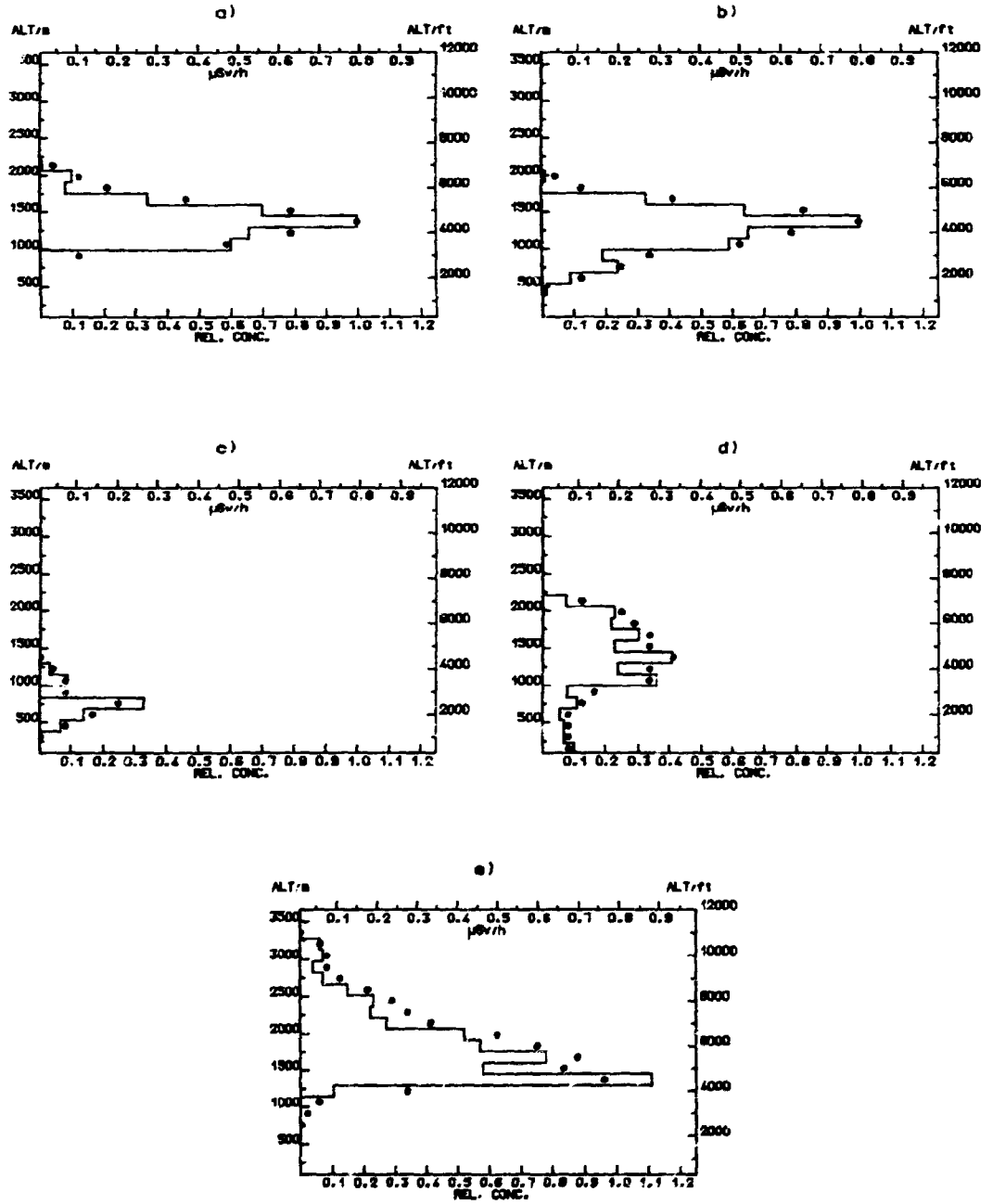

Fig. 7 Measured gamma radiation values (circles) and calculated distribution of the radioactivity concentration (solid line) during the flight at 1 - 3 p.m. on April 29, 1986. Relative concentration correspond to the concentrations of the air sample taken on April 29 (Table VII).

Table Ia. Radionuclide concentrations in ground-level air in Nurmijärvi from April 24 to June 30, 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From	To	^{7}Be	^{95}Zr	^{97}Zr	^{99}Mo	^{103}Ru	^{106}Ru	^{110m}Ag	^{115}Cd	^{125}Sb	^{127}Sb	^{129m}Te	^{131m}Te	^{132}Te
24.4. 09.35	28.4. 09.35	0[a]	150 000	0	280 000	300 000	103 000	0	0	0	0	0	0	1 030 000
28.4. 09.35	28.4. 15.10	0	164 000	17 000	450 000	390 000	84 000	0	43 000	0	159 000	260 000	153 000	3 300 000
28.4. 15.10	28.4. 22.10	0	380 000	0	2 440 000	2 880 000	630 000	130 000	400 000	253 000	1 650 000	4 000 000	1 700 000	33 000 000
28.4. 22.10	29.4. 08.50	0	208 000	8 400	320 000	219 000	85 000	0	40 000	0	33 000	73 000	26 000	790 000
29.4. 09.05	29.4. 15.45	0	64 000	2 300	93 000	77 000	33 000	0	6 700	0	6 400	9 400	0	118 000
29.4. 15.45	30.4. 09.20	0	4 600	0	55 000	101 000	48 000	1 700	5 800	0	26 000	117 000	20 000	760 000
30.4. 09.20	30.4. 15.45	0	0	0	8 500	15 600	15 000	0	0	0	0	7 900	0	147 000
30.4. 15.45	1.5. 15.45	0	770	0	10 800	22 700	8 100	770	0	1 600	9 300	32 000	2 600	174 000
1.5. 16.40	2.5. 15.55	0	670	0	6 600	17 800	8 200	540	0	0	4 300	22 000	620	98 000
2.5. 16.05	3.5. 13.50	0	0	0	1 100	3 600	3 800	0	0	0	860	4 600	0	20 200
3.5. 14.10	4.5. 14.35	0	470	0	3 800	13 400	7 500	540	0	1 000	3 300	21 000	0	66 000
4.5. 14.45	5.5. 15.15	0	0	0	1 500	8 700	6 300	290	0	0	2 000	13 000	0	33 000
5.5. 15.25	6.5. 15.00	3 300	290	0	290	2 600	2 700	0	0	0	0	0	0	7 800
6.5. 15.10	7.5. 13.25	3 700	173	0	330	5 500	3 500	0	0	0	0	4 400	0	6 000
7.5. 13.35	8.5. 14.45	4 800	2 160	0	820	15 800	4 700	140	0	0	480	12 000	0	15 800
8.5. 14.55	9.5. 14.10	6 500	590	0	1 130	24 400	8 100	0	0	460	850	20 000	0	20 800
9.5. 14.10	10.5. 13.00	4 900	290	0	2 670	68 000	18 200	0	0	840	900	32 000	0	26 200
10.5. 14.15	11.5. 15.40	3 400	91	0	580	38 000	9 900	0	0	420	360	13 000	0	9 800
11.5. 15.45	12.5. 14.20	4 500	0	0	340	30 000	10 300	0	0	0	0	9 300	0	5 700
12.5. 14.30	13.5. 13.15	1 670	0	0	108	19 900	6 300	0	0	230	68	5 900	0	2 700
13.5. 13.20	15.5. 09.30	2 680	0	0	0	1 130	280	0	0	0	0	830	0	310
15.5. 09.30	16.5. 13.05	3 300	0	0	0	870	0	0	0	0	0	0	0	194
16.5. 13.10	19.5. 13.00	1 590	36	0	0	820	335	0	0	0	0	810	0	118
19.5. 13.10	21.5. 13.00	3 190	0	0	0	1 840	480	0	0	0	0	1 900	0	160
21.5. 13.05	23.5. 13.50	2 300	66	0	0	1 310	380	18	0	0	0	890	0	71
23.5. 13.55	26.5. 10.40	3 800	0	0	0	3 670	1 310	0	0	62	0	1 900	0	90
26.5. 10.45	28.5. 10.40	1 800	131	0	0	1 340	480	23	0	0	0	1 080	0	0
28.5. 10.45	30.5. 10.10	2 400	41	0	0	990	340	0	0	59	0	610	0	0
30.5. 10.20	2.6. 10.55	2 280	27	0	0	680	290	0	0	60	0	580	0	0
2.6. 11.00	5.6. 10.30	2 400	0	0	0	1 700	680	0	0	0	0	1 180	0	0
5.6. 10.35	9.6. 11.25	2 750	13	0	0	780	350	5.3	0	10.3	0	700	0	0
9.6. 11.30	12.6. 10.35	4 000	0	0	0	410	181	0	0	16.8	0	340	0	0
12.6. 10.40	16.6. 11.40	3 620	24	0	0	720	350	3.7	0	12.9	0	360	0	0
16.6. 11.45	19.6. 10.00	2 950	14	0	0	120	71	3.0	0	9.4	0	130	0	0
19.6. 10.05	23.6. 11.00	3 840	11	0	0	187	102	2.8	0	8.5	0	150	0	0
23.6. 11.10	26.6. 11.05	4 300	1.6	0	0	99	60	2.2	0	7.0	0	110	0	0
26.6. 11.10	30.6. 10.30	4 000	140	0	0	128	86	2.9	0	8.4	0	92	0	0

[a] below the detection limit

Table Ia. cont.

From	To	^{131}I	^{133}I	^{134}Cs	^{136}Cs	^{137}Cs	^{140}Ba	^{141}Ce	^{143}Ce	^{144}Ce	^{147}Nd	^{239}Np
24.4. 09.35	28.4. 09.35	108 000 000	46 000 000	950 000	400 000	1 790 000	460 000	110 000	0[a]	102 000	23 000	780 000
28.4. 09.35	28.4. 15.10	52 000 000	13 700 000	820 000	320 000	1 400 000	1 000 000	178 000	50 000	132 000	40 000	880 000
28.4. 15.10	28.4. 22.10	223 000 000	48 000 000	7 200 000	2 740 000	11 900 000	7 000 000	570 000	240 000	410 000	150 000	1 900 000
28.4. 22.10	29.4. 08.50	7 300 000	1 260 000	177 000	66 000	320 000	450 000	220 000	45 000	162 000	68 000	840 000
29.4. 09.05	29.4. 15.45	5 900 000	770 000	58 000	19 000	96 000	155 000	78 000	12 000	51 000	28 000	280 000
29.4. 15.45	30.4. 09.20	7 100 000	650 000	94 000	37 000	155 000	129 000	7 500	0	0	0	22 000
30.4. 09.20	30.4. 15.45	7 000 000	420 000	33 000	11 500	56 000	48 000	0	0	0	0	0
30.4. 15.45	1.5. 15.45	2 890 000	119 000	51 000	17 700	84 000	45 000	1 340	0	0	0	0
1.5. 16.40	2.5. 15.55	3 000 000	61 000	28 200	9 900	49 000	18 000	310	0	0	0	0
2.5. 16.05	3.5. 13.50	1 850 000	20 000	7 700	2 400	13 200	4 300	0	0	0	0	0
3.5. 14.10	4.5. 14.35	1 730 000	8 800	33 000	9 700	56 000	16 000	540	0	0	0	0
4.5. 14.45	5.5. 15.15	1 300 000	0	20 500	6 300	35 000	8 600	0	0	0	0	0
5.5. 15.25	6.5. 15.00	740 000	0	5 400	1 600	9 100	2 500	190	0	0	0	0
6.5. 15.10	7.5. 13.25	510 000	0	3 500	950	6 100	2 700	300	0	0	0	0
7.5. 13.35	8.5. 14.45	620 000	0	7 200	1 900	12 600	7 700	2 500	0	1 800	0	0
8.5. 14.55	9.5. 14.10	500 000	0	9 700	2 600	17 400	8 900	950	0	750	0	0
9.5. 14.10	10.5. 13.00	350 000	0	10 200	2 700	18 600	10 000	600	0	0	0	0
10.5. 14.15	11.5. 15.40	310 000	0	4 100	940	7 500	2 920	277	0	0	0	0
11.5. 15.45	12.5. 14.20	299 000	0	2 900	770	5 400	1 630	0	0	0	0	0
12.5. 14.30	13.5. 13.15	170 000	0	4 000	780	7 500	750	0	0	0	0	0
13.5. 13.20	15.5. 09.30	81 000	0	490	113	940	190	0	0	0	0	0
15.5. 09.30	16.5. 13.05	71 000	0	370	0	700	0	0	0	0	0	0
16.5. 13.10	19.5. 13.00	41 000	0	1 550	221	2 720	210	44	0	0	0	0
19.5. 13.10	21.5. 13.00	39 000	0	1 140	142	1 990	350	56	0	0	0	0
21.5. 13.05	23.5. 13.50	27 900	0	640	67	1 150	240	82	0	96	0	0
23.5. 13.55	26.5. 10.40	20 300	0	990	136	1 800	290	38	0	118	0	0
26.5. 10.45	28.5. 10.40	9 200	0	870	65	1 570	290	109	0	167	0	0
28.5. 10.45	30.5. 10.10	8 600	0	430	30	730	96	44	0	29	0	0
30.5. 10.20	2.6. 10.55	7 900	0	200	0	410	0	29	0	0	0	0
2.6. 11.00	5.6. 10.30	8 200	0	160	5.3	278	0	0	0	0	0	0
5.6. 10.35	9.6. 11.25	5 200	0	170	12.3	320	25	16.8	0	20	0	0
9.6. 11.30	12.6. 10.35	2 080	0	160	5.6	290	45	12.7	0	0	0	0
12.6. 10.40	16.6. 11.40	2 380	0	190	6.6	360	21	20.3	0	22.2	0	0
16.6. 11.45	19.6. 10.00	1 350	0	150	4.3	270	16	10.5	0	17.8	0	0
19.6. 10.05	23.6. 11.00	570	0	150	4.1	280	10	10.2	0	14.2	0	0
23.6. 11.10	26.6. 11.05	460	0	110	2.5	210	4.0	2.8	0	3.9	0	0
26.6. 11.10	30.6. 10.30	370	0	160	2.8	290	18	70	0	189	0	0

[a] below the detection limit

Table Ib. Radionuclide concentrations in ground-level air in Nurmijärvi from June 30 to December 29, 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From		To		^{7}Be	^{95}Zr	^{103}Ru	^{106}Ru	^{110m}Ag	^{125}Sb	^{129m}Te	^{131}I	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
30.6.	10.40	3.7.	10.45	4180	26.5	109	71	7.8	13.3	84	12,3 [a]	207	390	15.5	39
3.7.	10.50	7.7.	10.50	2580	31	76	49	2.6	7.4	265	203 [a]	100	188	17 [b]	32
7.7.	10.55	10.7.	10.30	2250	1.8	33	28	1.3	2.1	106	3.0	52	95	0 [b]	0
10.7.	10.35	14.7.	13.55	1570	8.6	34	27	1.9	0	91	1.1	74	141	4.4	13.1
14.7.	14.05	17.7.	10.55	1790	5.6	24.6	22	1.6	3.6	187	0	60	113	3.1	8.6
17.7.	11.00	21.7.	11.00	2640	0	14.7	21	1.3	0	81	0	40	75	0	0
21.7.	11.10	24.7.	14.05	3260	0	33	32	1.3	3.3	266	0.97	57	109	0	0
24.7.	15.05	27.7.	16.10	4380	91	271	251	2.0	4.9	300	4.9	76	146	47	159
27.7.	16.15	28.7.	11.45	3170	0	25.8	0	0	0	67	0	77	145	0	0
28.7.	11.45	31.7.	10.05	3360	0.4	11.9	14.1	0.7	2.1	134	0	32	60	0	0
31.7.	11.05	7.8.	09.40	2620	4.0	16.5	19.5	1.84	2.9	78	0	49	94	2.2	7.3
7.8.	09.40	11.8.	09.35	2560	1.6	10.8	14.4	1.0	1.2	69	0	32	63	1.0	4.6
11.8.	09.40	14.8.	09.35	1760	1.6	6.8	10.5	0.7	0.87	75	0	31	58	0	2.3
14.8.	09.35	18.8.	09.35	3330	3.3	5.0	9.3	0.7	1.3	29	0	31	59	2.3	2.6
18.8.	09.40	21.8.	09.40	1280	0	4.6	11.5	0.92	0.79	72	0	25.9	49	0	0
21.8.	09.45	25.8.	09.30	1850	0	3.3	4.7	1.1	0.3	38	0	19.6	37	0	0
25.8.	09.35	28.8.	07.40	1200	1.5	2.93	8.9	0.78	0	24.3	0	21.4	41	0	2.9
28.8.	07.45	1.9.	07.40	980	1.2	3.7	6.2	1.1	0	0	0	23.2	47	1.3	4.7
1.9.	07.45	4.9.	07.40	2240	1.5	2.2	6.6	0	0	27	0	21.5	40	0	0
4.9.	07.45	8.9.	07.35	1190	0	2.1	0	0	0	24.1	0	17.9	36	0	0
8.9.	07.40	11.9.	07.45	1360	0	1.9	1.4	0.54	0.8	15.7	0	17.4	36	0	0
11.9.	07.50	15.9.	07.35	1570	0	0.97	0	0.47	0	10.4	0	14.4	31	0	0
15.9.	07.40	18.9.	07.30	940	0	3.7	0	0.92	0	0	0	36	73	0	0
18.9.	07.35	22.9.	07.35	1120	0.37	1.29	4.0	0.73	0.93	4.1	0	17.9	36	0	0
22.9.	07.40	25.9.	07.45	1390	0	0.83	0	0.47	1.9	19.3	0	16.2	33	0	0
25.9.	07.50	29.9.	07.30	1260	9.0	5.6	13.2	1.11	1.9	0	0	42	83	1.5	18.8
29.9.	07.35	2.10.	07.30	1340	0	1.7	7.9	0.55	1.0	0	0	22.8	44	0	0
2.10.	07.35	6.10.	07.30	1470	11.4	5.7	16.5	0.91	2.1	0	0	32	65	2.4	31
6.10.	07.35	9.10.	07.30	1770	0	1.7	0	0	0	0	0	24.5	50	0	0
9.10.	07.35	13.10.	07.30	1100	0	0.74	0	0	0	0	0	10.6	22.1	0	0
13.10.	07.35	16.10.	07.30	2220	0	1.9	6.1	0	1.9	13.1	0	24.1	50	0	0
16.10.	07.35	20.10.	07.30	1980	3.4	20.7	72	1.1	1.3	15.3	0	22.7	47	0.91	11.7
20.10.	07.35	23.10.	07.30	1840	8.7	28.6	106	1.9	2.2	32	0	30	62	1.5	24.8
23.10.	07.35	27.10.	07.35	1480	0	1.9	11.0	0.48	1.0	0	0	8.1	18.0	0	0
27.10.	07.40	3.11.	07.35	1400	0	3.8	14.7	0.44	0.3	6.8	0	14.3	30	0	0.54
3.11.	07.40	10.11.	07.30	1280	0	0.71	3.1	0.18	0.54	0	0	8.1	17.4	0	0
10.11.	07.35	17.11.	08.10	1910	0.39	5.1	24.9	0.24	1.0	3.7	0	20.5	45	0	1.2
17.11.	08.10	24.11.	07.25	1520	0.46	4.1	22.7	0.26	0.3	0	0	12.1	26.8	0	1.6
24.11.	07.30	1.12.	05.30	1290	18.4	6.4	45	0.23	1.2	0	0	17.9	38	2.0	85
1.12.	05.35	8.12.	07.30	1960	7.2	5.1	38	2.6	10.0	0	0	337	745	0.93	26.4
8.12.	07.35	15.12.	07.30	2290	0	3.7	28.2	0.26	1.1	0	0	55	123	0	0
15.12.	07.35	22.12.	07.30	2140	1.4	5.2	42	1.5	5.8	0	0	85	180	0	8.3
22.12.	07.35	29.12.	05.25	1630	1.7	1.7	15.4	0.39	2.7	0	0	40	86	0	0

[a] aerosols and other chemical forms together
[b] below the detection limit

Table IIa. Radionuclide concentrations in ground-level air in Helsinki from April 28 to May 4, 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From	To	^{95}Zr	^{97}Zr	^{99}Mo	^{103}Ru	^{106}Ru	^{127}Sb	^{129m}Te	^{131m}Te	^{132}Te	^{131}I
28.4. 17.30	28.4. 18.50	181 000	15 400	660 000	510 000	360 000	255 000	570 000	171 000	5 600 000	16 700 000
28.4. 18.55	28.4. 20.45	149 000	13 900	650 000	700 000	420 000	279 000	730 000	224 000	6 500 000	18 900 000
28.4. 20.50	28.4. 21.55	1 100 000	75 000	2 800 000	3 200 000	1 350 000	1 030 000	2 280 000	730 000	20 700 000	31 000 000
28.4. 21.55	28.4. 22.55	1 210 000	82 000	2 430 000	1 620 000	630 000	380 000	1 050 000	267 000	8 800 000	15 000 000
28.4. 23.00	28.4. 23.55	1 480 000	76 000	2 350 000	1 630 000	590 000	263 000	760 000	216 000	6 200 000	11 100 000
29.4. 00.00	29.4. 00.55	1 590 000	64 000	1 790 000	1 010 000	350 000	164 000	490 000	82 000	4 800 000	7 700 000
29.4. 01.00	29.4. 01.50	1 050 000	45 000	1 380 000	1 090 000	350 000	115 000	0	78 000	3 400 000	6 000 000
29.4. 01.55	29.4. 02.50	1 150 000	55 000	1 360 000	1 100 000	430 000	112 000	0	106 000	2 970 000	4 000 000
29.4. 02.55	29.4. 03.55	840 000	47 000	1 100 000	730 000	0	82 000	0	0	2 630 000	3 100 000
29.4. 04.00	29.4. 04.50	660 000	40 000	890 000	560 000	150 000	88 000	0	0	2 130 000	2 500 000
29.4. 04.55	29.4. 05.50	540 000	29 000	620 000	470 000	180 000	49 000	0	0	1 660 000	2 410 000
29.4. 05.55	29.4. 06.50	234 000	19 000	380 000	177 000	84 000	0	0	0	1 040 000	2 230 000
29.4. 06.55	29.4. 07.50	142 000	8 400	274 000	119 000	0	0	0	0	540 000	1 700 000
29.4. 07.55	29.4. 08.50	108 000	7 100	136 000	95 000	0	17 000	0	0	320 000	1 310 000
29.4. 08.55	29.4. 11.10	44 000	1 200	42 000	34 000	0	0	0	0	109 000	560 000
29.4. 11.10	29.4. 12.10	0	0	8 700	0	0	0	0	0	21 400	294 000
29.4. 12.10	29.4. 13.10	22 700	0	27 000	42 000	0	0	0	0	66 000	310 000
29.4. 13.35	29.4. 14.25	0	0	7 200	5 300	0	0	0	0	39 000	224 000
29.4. 14.30	29.4. 18.50	5 400	0	6 500	2 680	0	0	0	0	13 900	179 000
29.4. 18.55	29.4. 23.35	25 000	0	215 000	400 000	186 000	79 000	380 000	94 000	2 870 000	4 900 000
29.4. 23.45	30.4. 03.50	6 400	0	146 000	253 000	167 000	77 000	235 000	51 000	2 200 000	3 500 000
30.4. 03.50	30.4. 07.05	0	0	144 000	295 000	140 000	54 000	340 000	86 000	2 160 000	2 550 000
30.4. 07.05	30.4. 13.25	0	0	38 000	60 000	43 000	25 900	60 000	12 000	530 000	1 380 000
30.4. 13.25	30.4. 17.40	0	0	36 000	64 000	54 000	30 000	110 000	14 900	600 000	1 140 000
30.4. 17.45	30.4. 22.00	0	0	38 000	50 000	59 000	31 000	85 000	10 700	620 000	840 000
30.4. 22.05	1.5. 02.00	0	0	13 600	13 600	19 300	8 400	24 400	2 400	143 000	410 000
1.5. 02.00	1.5. 04.00	0	0	11 300	14 500	0	7 100	0	4 500	114 000	480 000
1.5. 04.00	1.5. 06.00	8 400	0	6 900	13 400	17 600	0	0	0	101 000	600 000
1.5. 06.00	1.5. 07.55	9 400	0	14 200	30 500	0	9 800	62 000	9 200	201 000	1 010 000
1.5. 07.55	1.5. 10.00	0	0	9 600	16 600	32 000	4 100	0	0	133 000	790 000
1.5. 10.00	1.5. 12.15	0	0	4 500	9 800	22 300	2 300	0	0	74 000	660 000
1.5. 12.15	1.5. 14.15	0	0	5 300	12 200	13 300	5 000	19 500	0	96 000	700 000
1.5. 14.15	1.5. 17.45	0	0	7 200	16 700	50 000	4 200	21 500	0	98 000	760 000
1.5. 17.45	1.5. 22.25	0	0	7 800	23 300	19 600	5 300	0	0	109 000	960 000
1.5. 22.30	2.5. 03.50	0	0	13 500	28 200	84 000	0	0	0	183 000	2 440 000
2.5. 03.50	2.5. 06.55	5 900	0	14 200	43 000	29 000	0	0	0	210 000	860 000
2.5. 06.55	2.5. 11.50	930	0	5 700	27 800	10 800	7 400	29 300	0	144 000	1 030 000
2.5. 11.55	2.5. 16.55	0	0	6 300	18 900	13 600	6 400	30 000	0	129 000	840 000
2.5. 17.00	2.5. 21.30	0	0	3 100	8 200	7 700	0	0	0	52 000	530 000
2.5. 21.30	3.5. 07.30	0	0	2 800	10 000	9 000	2 680	16 800	0	57 000	360 000
3.5. 07.30	3.5. 12.20	0	0	10 000	31 000	19 700	8 600	42 000	0	174 000	790 000
3.5. 12.20	3.5. 16.15	0	0	10 600	41 000	33 000	13 600	82 000	0	216 000	940 000
3.5. 16.15	3.5. 20.15	0	0	9 400	39 000	16 200	9 100	45 000	0	193 000	1 030 000
3.5. 20.15	4.5. 00.15	0	0	11 700	31 000	23 100	8 100	45 000	0	152 000	760 000
4.5. 00.15	4.5. 07.40	0	0	5 500	23 800	16 400	5 800	35 000	0	119 000	470 000
4.5. 07.40	4.5. 12.10	0	0	3 700	18 900	12 200	5 700	31 000	0	82 000	530 000
4.5. 12.10	4.5. 16.50	2 000	0	3 800	13 700	16 000	2 400	28 600	0	57 000	500 000

Table IIa. cont.

From	To	^{133}I	^{134}Cs	^{136}Cs	^{137}Cs	^{140}Ba	^{141}Ce	^{143}Ce	^{144}Ce	^{147}Nd	^{239}Np
28.4. 17.30	28.4. 18.50	3 800 000	1 650 000	570 000	2 760 000	1 300 000	180 000	0[a]	143 000	130 000	810 000
28.4. 18.55	28.4. 20.45	4 100 000	1 780 900	630 000	3 100 000	1 380 000	162 000	0	0	153 000	770 000
28.4. 20.50	28.4. 21.55	6 300 000	4 200 000	1 690 000	7 200 000	5 000 000	1 200 000	52 000	1 060 000	380 000	4 400 000
28.4. 21.55	28.4. 22.55	2 890 000	1 710 000	630 000	2 880 000	3 500 000	1 280 000	213 000	1 080 000	510 000	5 900 000
28.4. 23.00	28.4. 23.55	2 010 000	1 230 000	450 000	2 030 000	2 700 000	1 380 000	275 000	1 170 000	510 000	5 300 000
29.4. 00.00	29.4. 00.55	1 520 000	920 000	320 000	1 510 000	2 690 000	1 490 000	226 000	1 100 000	540 000	6 100 000
29.4. 01.00	29.4. 01.50	1 020 000	600 000	240 000	1 090 000	1 740 000	1 000 000	152 000	750 000	490 000	4 200 000
29.4. 01.55	29.4. 02.50	690 000	510 000	188 000	880 000	1 760 000	1 120 000	160 000	950 000	510 000	4 500 000
29.4. 02.55	29.4. 03.55	490 000	480 000	209 000	830 000	1 580 000	830 000	0	620 000	430 000	3 300 000
29.4. 04.00	29.4. 04.50	400 000	410 000	115 000	670 000	1 300 000	660 000	0	430 000	400 000	2 650 000
29.4. 04.55	29.4. 05.50	330 000	320 000	113 000	540 000	960 000	550 000	0	265 000	390 000	2 110 000
29.4. 05.55	29.4. 06.50	277 000	210 000	76 000	350 000	490 000	250 000	0	105 000	238 000	960 000
29.4. 06.55	29.4. 07.50	243 000	126 000	30 000	195 000	320 000	141 000	0	101 000	132 000	610 000
29.4. 07.55	29.4. 08.50	170 000	61 000	21 000	124 000	185 000	97 000	0	40 000	105 000	350 000
29.4. 08.55	29.4. 11.10	74 000	19 500	7 200	35 000	76 000	37 000	0	21 800	21 800	137 000
29.4. 11.10	29.4. 12.10	41 000	3 600	0	9 400	0	0	0	0	0	0
29.4. 12.10	29.4. 13.10	44 000	7 000	0	12 600	48 000	20 900	0	19 700	20 000	94 000
29.4. 13.35	29.4. 14.25	27 200	3 900	0	6 400	9 600	3 200	0	0	0	10 600
29.4. 14.30	29.4. 18.50	20 000	1 880	780	4 200	5 300	6 000	0	0	4 200	26 500
29.4. 18.55	29.4. 23.35	460 000	273 000	111 000	470 000	380 000	2 500	0	0	0	87 000
29.4. 23.45	30.4. 03.50	299 000	310 000	121 000	530 000	340 000	2 700	0	0	0	55 000
30.4. 03.50	30.4. 07.05	190 000	195 000	82 000	330 000	279 000	0	0	0	0	0
30.4. 07.05	30.4. 13.25	89 000	94 000	37 000	164 000	106 000	0	0	0	0	15 500
30.4. 13.25	30.4. 17.40	64 000	143 000	55 000	249 000	174 000	0	0	0	0	0
30.4. 17.45	30.4. 22.00	43 000	183 000	62 000	300 000	176 000	0	0	0	0	0
30.4. 22.05	1.5. 02.00	17 900	43 000	14 500	72 000	49 000	4 600	0	2 500	0	0
1.5. 02.00	1.5. 04.00	19 500	24 400	7 300	42 000	45 000	0	0	0	0	0
1.5. 04.00	1.5. 06.00	24 000	19 900	3 600	33 000	39 000	5 600	0	0	0	8 000
1.5. 06.00	1.5. 07.55	38 000	44 000	14 000	74 000	53 000	8 300	0	0	0	14 700
1.5. 07.55	1.5. 10.00	27 500	31 000	12 000	53 000	26 900	0	0	0	0	0
1.5. 10.00	1.5. 12.15	18 300	19 600	9 000	36 000	19 000	0	0	0	0	0
1.5. 12.15	1.5. 14.15	20 400	22 000	7 600	39 000	19 500	0	0	0	0	0
1.5. 14.15	1.5. 17.45	20 800	21 700	7 700	41 000	15 300	0	0	0	0	0
1.5. 17.45	1.5. 22.25	23 300	27 000	8 400	44 000	20 500	0	0	0	0	0
1.5. 22.30	2.5. 03.50	33 000	41 000	18 700	69 000	0	0	0	0	0	0
2.5. 03.50	2.5. 06.55	18 400	59 000	20 200	92 000	50 000	8 100	0	0	0	11 400
2.5. 06.55	2.5. 11.50	18 000	46 000	15 600	79 000	31 000	1 660	0	0	0	5 200
2.5. 11.55	2.5. 16.55	11 900	48 000	14 600	82 000	22 900	0	0	0	0	0
2.5. 17.00	2.5. 21.30	6 700	18 700	4 500	33 000	13 300	0	0	0	0	0
2.5. 21.30	3.5. 07.30	4 400	22 900	6 600	38 000	13 000	0	0	0	0	0
3.5. 07.30	3.5. 12.20	7 400	75 000	22 600	123 000	36 000	0	0	0	0	0
3.5. 12.20	3.5. 16.15	5 600	100 000	29 200	163 000	46 000	0	0	0	0	0
3.5. 16.15	3.5. 20.15	7 000	92 000	24 100	151 000	48 000	0	0	0	0	0
3.5. 20.15	4.5. 00.15	4 600	72 000	21 500	121 000	36 000	0	0	0	0	0
4.5. 00.15	4.5. 07.40	0	59 000	16 400	97 000	25 000	0	0	0	0	0
4.5. 07.40	4.5. 12.10	1 500	43 000	13 200	74 000	19 000	0	0	0	0	0
4.5. 12.10	4.5. 16.50	2 800	33 000	9 900	51 000	20 200	0	0	0	0	0

[a] below the detection limit

Table IIb. Radionuclide concentrations in ground-level air in Helsinki from May 4 to August 7, 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From	To	^{95}Zr	^{99}Mo	^{103}Ru	^{106}Ru	^{127}Sb	^{129m}Te	^{132}Te	^{131}I	^{134}Cs	^{136}Cs	^{137}Cs	^{140}Ba	^{141}Ce	^{144}Ce
4.5. 16.50	4.5. 22.55	0[a]	2 250	12 000	17 000	5 000	0	52 000	440 000	31 000	7 400	53 000	10 600	0	0
4.5. 22.55	5.5 08.20	0	1 320	6 100	13 100	0	0	27 200	184 000	16 800	4 600	25 800	10 400	0	0
5.5 08.20	5.5. 12.50	0	2 030	22 600	6 000	0	0	35 000	310 000	22 600	4 600	36 000	12 700	0	0
5.5. 12.50	5.5. 17.30	0	1 100	7 300	15 100	0	0	23 800	239 000	17 200	4 900	27 500	12 000	0	0
5.5. 17.30	5.5. 20.50	0	0	4 600	14 500	0	0	16 800	205 000	9 200	3 900	14 100	6 000	0	0
5.5. 20.50	6.5. 07.55	0	460	3 300	4 900	0	0	10 000	129 000	6 200	1 610	11 700	0	0	0
6.5. 07.55	6.5. 13.30	0	480	3 300	6 800	0	0	8 900	171 000	6 700	2 440	12 100	3 800	1 500	0
6.5. 13.30	6.5. 17.50	0	640	3 800	9 900	0	0	9 200	180 000	8 700	2 650	13 900	5 500	0	0
6.5. 17.50	6.5. 21.30	0	0	2 900	0	0	0	8 500	162 000	4 500	1 350	8 300	0	0	0
6.5. 21.30	7.5. 07.30	3 000	0	1 520	0	0	0	5 300	108 000	4 400	0	7 200	4 800	3 000	0
7.5. 07.30	7.5. 11.30	0	0	4 900	0	0	0	7 400	240 000	3 200	0	7 700	0	0	0
7.5. 11.30	7.5. 20.55	3 500	0	11 900	0	0	0	12 400	228 000	6 700	1 710	11 000	5 600	3 300	0
7.5. 20.55	8.5. 08.30	2 900	590	4 900	4 700	0	0	6 400	139 000	5 700	860	8 900	8 300	3 800	3 100
8.5. 08.30	8.5. 20.30	0	710	11 700	4 800	0	0	13 300	135 000	7 200	1 750	13 300	4 600	0	0
8.5. 20.30	9.5. 08.30	0	1 090	27 300	6 300	0	24 800	24 600	81 000	11 100	3 200	18 700	8 900	0	0
9.5. 08.30	9.5. 12.30	0	1 970	31 000	0	0	40 000	24 500	92 000	12 600	4 000	21 100	13 800	0	0
9.5. 12.30	9.5. 20.15	0	1 140	32 000	7 900	0	20 200	25 900	102 000	13 600	3 400	22 600	13 700	0	0
9.5. 20.15	10.5. 08.25	0	550	27 900	8 700	0	16 900	13 900	75 000	6 800	1 400	12 000	6 900	0	0
10.5. 08.30	10.5. 15.45	1 100	3 700	26 600	70 000	3 400	81 000	71 000	144 000	23 600	6 400	45 000	16 500	0	0
10.5. 15.45	11.5. 10.45	0	250	17 700	5 200	0	5 500	4 300	39 000	2 710	490	4 500	1 200	0	0
11.5. 10.50	12.5. 07.50	0	310	39 000	13 900	0	14 700	7 800	38 000	3 400	0	6 500	2 640	0	0
12.5. 07.50	12.5. 16.20	0	0	42 000	0	0	0	7 100	46 000	3 200	0	6 700	0	0	0
12.5. 16.20	13.5. 10.00	0	160	21 200	8 000	0	6 500	3 000	16 900	1 380	460	2 530	0	0	0
13.5. 10.00	14.5. 10.10	0	0	550	0	0	0	180	6 700	340	0	560	0	0	0
14.5. 10.10	15.5. 09.55	0	0	870	0	0	0	330	5 700	570	0	1 110	0	0	0
15.5. 10.00	16.5. 10.00	0	0	1 100	0	0	0	230	7 200	650	0	1 110	440	0	0
16.5. 10.00	17.5. 10.00	0	0	920	0	0	0	220	3 100	710	0	1 140	0	0	0
17.5. 10.00	19.5. 10.15	0	0	470	0	0	0	0	2 810	520	0	1 000	0	120	0
19.5. 10.15	21.5. 10.30	0	0	1 930	0	0	0	170	3 500	1 290	0	2 300	0	0	0
21.5. 10.30	23.5. 14.50	0	0	1 340	490	0	990	0	1 920	610	0	1 060	210	0	0
23.5. 14.55	26.5. 13.55	78	0	5 300	1 940	0	2 810	140	2 490	1 250	123	2 240	250	45	112
26.5. 13.55	30.5. 13.05	28	0	1 150	430	0	690	19	620	590	59	1 050	125	34	39
30.5. 13.05	2.6. 14.05	0	0	980	0	0	0	0	580	350	0	560	0	0	0
2.6. 14.05	5.6. 12.55	26	0	1 420	620	0	790	0	500	189	0	350	69	41	57
5.6. 12.55	9.6. 15.55	0	0	710	520	0	910	0	230	272	0	550	0	0	0
9.6. 15.55	12.6. 14.55	56	0	440	250	0	390	0	88	215	0	420	0	17	87
12.6. 14.55	19.6. 11.00	16	0	400	220	0	130	0	42	179	0	320	35	11	0
19.6. 11.00	23.6. 14.35	0	0	205	110	0	0	0	40	140	0	279	0	12	0
23.6. 14.40	26.6. 13.35	0	0	115	68	0	190	0	29	154	0	260	0	0	0
26.6. 13.35	4.7. 14.45	14.7	0	77	54	0	94	0	7.1	156	0	290	0	10	19
4.7. 14.45	11.7. 14.10	10.0	0	42	31	0	100	0	3.8	57	0	105	0	6.3	16
11.7. 14.10	18.7. 13.45	0	0	28	29	0	150	0	0	55	0	103	0	0	0
18.7. 13.45	26.7. 11.25	127	0	290	240	0	200	0	3.8	45	0	87	0	50	130
26.7. 11.25	27.7. 14.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.7. 14.00	28.7. 10.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.7. 10.10	1.8. 11.45	0	0	15	0	0	140	0	0	41	0	76	0	0	0
1.8. 11.45	7.8. 13.30	0	0	18	24	0	102	0	0	51	0	99	0	0	0

[a] below the detection limit

Table III. Radionuclide concentrations analysed from ground-level air in Rovaniemi in 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From	To	^{7}Be	^{103}Ru	^{131}I	^{134}Cs	^{136}Cs	^{137}Cs
6.5. 15.30	8.5. 15.00	3 400	11 000	36 000	6 200	1 790	10 500
8.5. 15.05	10.5. 12.05	2 500	2 340	14 400	1 260	350	2 120
10.5. 12.10	12.5. 15.40	6 000	42 000	35 000	4 600	790	8 500
12.5. 15.40	14.5. 16.15	5 000	12 100	12 200	1 560	220	2 840
14.5. 16.20	16.5. 15.30	2 000	510	2 000	300	97	540
16.5. 15.35	18.5. 12.15	2 600	1 650	2 750	810	130	1 500
18.5. 12.20	20.5. 15.40	3 000	2 270	2 050	790	0[a]	1 380
20.5. 15.40	21.5. 15.35	1 800	970	1 340	600	0	940
21.5. 15.40	23.5. 15.40	1 700	940	940	360	0	670
23.5. 15.40	25.5. 13.50	2 600	2 160	980	750	0	1 240
25.5. 13.50	27.5. 14.05	2 500	1 500	1 130	690	64	1 240
27.5. 14.10	29.5. 15.20	2 800	1 930	0	590	0	1 130
29.5. 15.20	31.5. 12.00	-[b]	-	-	-	-	-
31.5. 12.00	2.6. 12.00	2 200	630	210	200	0	360
2.6. 12.00	5.6. 13.30	5 700	2 230	360	280	0	510
5.6. 13.35	9.6. 08.45	2 800	1 080	110	710	0	1 270
9.6. 08.50	12.6. 13.50	4 200	410	83	130	0	250
12.6. 13.55	16.6. 10.15	2 500	170	0	48	0	97
16.6. 10.20	19.6. 11.40	-	-	-	-	-	-
19.6. 11.45	23.6. 12.50	3 200	83	0	29	0	43
23.6. 12.55	26.6. 15.05	5 800	69	0	33	0	71
26.6. 15.10	30.6. 14.35	2 900	24	0	20	0	30

[a] below the detection limit
[b] not analysed

Table IV. Concentrations of aerosol and gaseous form of ^{131}I in air and penetration through the glass fibre filter in Nurmijärvi in 1986 ($\mu Bq/m^3$).

From	To	Glass fibre filter	Carbon bed	Penetration (%)
29.4. 09.05	2.5. 15.55	640 000[a]	3 500 000	85
2.5. 16.05	3.5. 13.50	196 000	1 650 000	89
3.5. 14.10	4.5. 14.35	265 000	1 470 000	85
4.5. 14.45	5.5. 15.15	195 000	1 110 000	85
5.5. 15.25	6.5. 15.00	112 000	620 000	85
6.5. 15.10	7.5. 13.25	124 000	390 000	76
7.5. 13.35	8.5. 14.45	128 000	490 000	79
8.5. 14.55	9.5. 14.10	73 000	430 000	85
9.5. 14.10	10.5. 13.00	70 000	280 000	80
10.5. 14.15	12.5. 14.20	30 000[a]	260 000	90
12.5. 14.30	13.5. 13.15	18 500	155 000	89
13.5. 13.20	15.5. 09.30	4 900	76 000	94
15.5. 09.30	16.5. 13.05	4 800	67 000	93
16.5. 13.10	19.5. 13.00	2 280	38 000	94
19.5. 13.10	21.5. 13.00	2 810	36 000	93
21.5. 13.05	23.5. 13.50	1 930	26 100	93
23.5. 13.55	26.5. 10.40	1 960	18 200	90
26.5. 10.45	28.5. 10.40	860	8 400	91
28.5. 10.45	30.5. 10.10	550	8 100	94
30.5. 10.20	2.6. 10.55	400	7 500	95
2.6. 11.00	5.6. 10.30	520	7 600	94
5.6. 10.35	9.6. 11.25	233	5 000	96
9.6. 11.30	12.6. 10.35	98	2 010	95
12.6. 10.40	16.6. 11.40	87	2 290	96
16.6. 11.45	19.6. 10.00	41	1 310	97
19.6. 10.05	23.6. 11.00	31	540	95
23.6. 11.10	26.6. 11.05	21	440	95
26.6. 11.10	30.6. 10.30	14	350	96

[a] mean value weighted with air volume

Table V. Concentrations of transuranic elements in ground-level air in Nurmijärvi from April 28 to May 15, 1986 (μBq/m³). The results are calculated to the median of the sampling period.

From	To	^{238}Pu	^{239,240}Pu	^{242}Pu	^{241}Am	^{242}Cm	^{243,244}Cm
28.4. 09.35	28.4. 15.10	41	97	1.5	10	1500	11
28.4. 15.10	28.4. 22.10	81	180	2.4	19	3400	20
28.4. 22.10	29.4. 08.50	41	94	1.4	10	1400	8
29.4. 09.05	29.4. 15.45	27	50	1.6	11	400	1.7
29.4. 15.45	30.4. 09.20	1.3	3.3	1.2	0.71	370	0.16
30.4. 09.20	30.4. 15.45	0.60	0.50	0.44	2.4	2.5	0.97
30.4. 15.45	1.5. 15.45	0.26	0.22	-[a]	0[b]	3.3	0.13
1.5. 16.40	2.5. 15.55	0.23	0.56	-	0	4.0	0
2.5. 16.05	3.5. 13.50	0.008	0.088	-	0	0.58	0
3.5. 14.10	4.5. 14.35	0.12	0.11	-	0	3.4	0
4.5. 14.45	5.5. 15.15	-	-	-	0.090	2.4	0.090
5.5. 15.25	6.5. 15.00	-	-	-	-	-	-
6.5. 15.10	7.5. 13.25	0	0.25	-	0.10	2.3	0.060
7.5. 13.35	8.5. 14.45	0.060	1.2	-	0.10	0.65	0.030
8.5. 14.55	9.5. 14.10	0.31	0.26	-	0.24	2.2	0
9.5. 14.10	10.5. 13.00	0.070	0.13	-	0.22	0.65	0
10.5. 14.15	11.5. 15.40	0.030	0.040	-	0.11	0	0.090
11.5. 15.45	12.5. 14.20	0.040	0.12	-	0.070	0.26	0
12.5. 14.30	13.5. 13.15	0.040	0.10	-	0	1.7	0.14
13.5. 13.20	15.5. 09.30	0.030	0.030	-	0	0	0

[a] not analysed
[b] below the detection limit

Table VI. Concentrations of transuranic elements in ground-level air in Helsinki from April 29 to May 1, 1986 ($\mu Bq/m^3$). The results are calculated to the median of the sampling period.

From		To		^{238}Pu	$^{239,240}Pu$	^{241}Am	^{242}Cm	$^{243,244}Cm$
29.4.	13.35	29.4.	14.25	5.0	3.5	12	200	26
29.4.	14.30	29.4.	18.50	1.4	0[a]	11	45	6.4
29.4.	18.55	29.4.	23.35	3.7	11	-[b]	-	-
29.4.	23.45	30.4.	03.45	0	3.0	-	-	-
30.4.	03.50	30.4.	07.05	0.90	0	-	-	-
30.4.	07.05	30.4.	13.25	1.2	1.7	-	-	-
30.4.	13.25	30.4.	17.40	7.0	12	5.5	27	0
30.4.	17.40	30.4.	22.00	1.1	1.4	-	-	-
1.5.	06.00	1.5.	07.55	4.4	0.26	-	-	-
1.5.	07.55	1.5.	10.00	5.6	0	-	-	-
1.5.	10.00	1.5.	12.15	0	0	-	-	-
1.5.	12.15	1.5.	14.15	2.0	0.76	15	110	0
1.5.	17.45	1.5.	22.25	4.2	2.7	-	-	-

[a] below the detection limit
[b] not analysed

Table VII. Airborne radioactivity at various altitudes in southern Finland 1986 (note the unit mBq/m^3).

Date	Sampling region	Sampling height (m)	^{95}Zr	^{99}Mo	^{103}Ru	^{106}Ru	^{127}Sb	^{129m}Te	^{132}Te	^{131}I	^{133}I	^{134}Cs	^{136}Cs	^{137}Cs	^{140}Ba	^{141}Ce	^{144}Ce	^{239}Np
28.4.	Vaasa, south	500	460	1940	1500	1150	730	1510	17600	38000	8500	3800	1430	6600	4000	550	580	1820
29.4.	Helsinki, east	1500	0[a]	19800	28500	27000	20500	52000	420000	690000	77000	97000	35000	167000	65000	0	0	0
30.4.	Kotka	50	0	20	21	0	0	0	350	4600	330	95	47	159	192	0	0	0
30.4.	Helsinki, west	1000	0	63	116	0	0	0	980	3800	246	129	57	221	182	0	0	78
30.4.	Lahti, north	1500	0	114	237	152	99	0	1890	3600	234	410	152	700	340	0	0	0
5.5.	Lahti, east	300	0	0	0	0	0	0	9.4	178	0	0	0	9.3	0	0	0	0
5.5.	Lahti, east	2000	0	0	29.6	0	0	0	28.3	390	0	0	0	43	0	0	0	0
8.5.	Helsinki, north	500	0	0	51	0	0	0	31	650	0	23	0	39	0	0	0	0
8.5.	Kouvola, south	1500	0	0	60	0	0	0	49	420	0	34	8.3	57	40	0	0	0
8.5.	Salo, south	2500	0	0	115	0	0	0	89	2500	0	50	0	93	0	0	0	0
9.5.	The Baltic Sea	500	0	63	3900	1290	0	850	1140	4500	0	297	44	480	240	0	0	0
9.5.	The Gulf of Finland	1000	0	0	74	0	0	0	56	830	0	32	0	89	0	0	0	0
9.5.	Salo, south	2500	0	0	12.1	0	0	0	13.1	117	0	12	0	29	0	0	0	0
10.5	Hanko, east	1500	13	17	1170	340	11	330	268	940	0	84	14	149	93	8.7	0	0
10.5.	Turku, NE	1500	0	0	5.8	0	0	0	3.9	45	0	5.0	0	7.3	0	0	0	0
11.5.	Hanko, east	1500	0	0	8.6	0	0	0	4.4	20.6	0	6.0	0	10.2	1.5	0	0	0
11.5.	Tampere, south	1500	0	0	8.4	0	0	0	5.6	30	0	9.7	0	20.4	0	0	0	0

[a] below the detection limit

Table VIII. Radioactivity of various nuclides in ten hot particles isolated from the three air dust samples collected in Nurmijärvi (note the unit Bq).

From	To	Spot number	^{95}Zr	^{106}Ru	^{134}Cs	^{137}Cs	^{144}Ce
27.4. 15.00	28.4. 09.35	1	5.3	0	0	0	4.8
27.4. 15.00	28.4. 09.35	2	0	12.3	4.4	8.4	1.3
27.4. 15.00	28.4. 09.35	3	0	2.4	3.6	7.0	2.8
28.4. 09.35	28.4. 15.10	4	40	2.9	0	0	18.0
28.4. 09.35	28.4. 15.10	5	0	9.0	0	0	0
28.4. 09.35	28.4. 15.10	6	0	0	0	0	0
28.4. 15.10	28.4. 22.10	7	0	2.6	0	0	1.1
28.4. 15.10	28.4. 22.10	8	0	4.8	0	0	0
28.4. 15.10	28.4. 22.10	9	9.1	2.3	0	0	3.2
28.4. 15.10	28.4. 22.10	10	0	0	0	0	0.8

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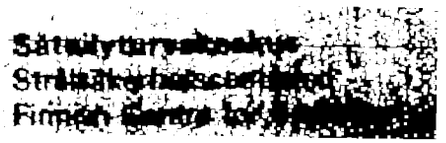

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