Report from Seibersdorf: Post-accident radiological measurements

Data from the Agency's laboratory in Austria

by Rieder Schelenz and Ahmed A. Abdel-Rassoul

Correction:

Readers, please note:

Lines 11 and 12, p.23, col.2, should read:

cubic metre of the total activity was observed on 10 May 1986. The maximum activity of 13.2 becquerel per cubic metre for I-131 was . . .

In the second table, p.25, col.2, the correct dates of sampling are: 3 May, 4 May, 5 May, 6 May, 7 May.

On page 26, the last line should say 8.05 days; the 9th line from bottom should say radiocaesium, not caesium.

The Editor regrets the errors.

On Tuesday 29 April 1986, in the early morning, shortly following the announcement of the reactor accident at the Chernobyl nuclear power plant Unit-4 in the USSR, the Chemistry Unit of the Agency's Laboratory at Seibersdorf initiated several tests measuring the local radioactivity.* The samples were mostly collected from areas surrounding the laboratories and from the Agency premises in Vienna (at the Vienna International Centre). Also some samples collected in other areas were analysed. Radioactivity was first measured in air, grass, soil, rainwater, and fruit and carried out continuously during the period 29 April to 30 May 1986.

Nine radionuclides were found and identified in almost all analysed samples: barium-140, caesium-134, caesium-137, iodine-131, iodine-132, molybdenum-99, ruthenium-103, strontium-90, and tellurium-132. Ten other radionuclides — cerium-141, cerium-144, caesium-136, iodine-133, iodine-134, niobium-95, rhodium-106, ruthenium-106, tellurium-129, and zirconium-95 — also were identified in a number of matrices. (For the recalibration of the measuring systems, Certified Reference Materials (CRMs) of the Agency's Analytical Quality Control Services (AQCS) were used.)

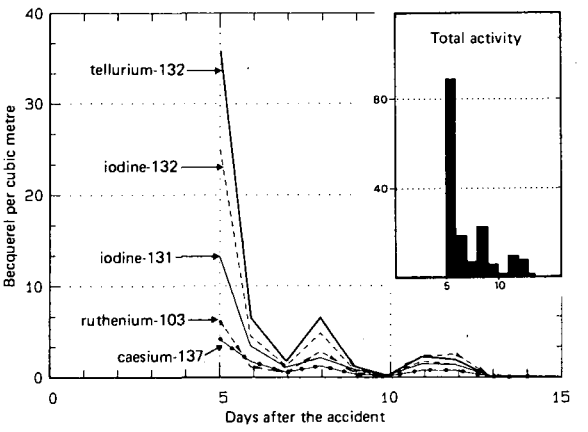
Although more than 1000 radionuclide measurements were performed (mainly originating from the area of the Agency's laboratories in Seibersdorf) the exemplary character of these radiological measurements must be strongly emphasized. The results should not be referred to for any conclusive action nor for implementing restrictive measures on national or regional levels.

Air measurements

The radioactivity of airborne particles at ground-level air was measured by analysing the glass-fibre filters of air samplers installed at the Agency's laboratories in Seibersdorf and at the Vienna International Centre (VIC). The highest activities were attributed to the short-lived radionuclides tellurium-132/iodine-132 accounting for two-thirds of the total activity at the time of maximum level. The maximum of 91 becquerel per cubic metre of the total activity was observed on 1 May 1986 at 00:20 a.m., the minimum of 0.04 becquerel per cubic metre of the total activity was observed on 1 May 1986 at 00:20 a.m., the minimum of 0.04 becquerel per measured on filters collected on 1 May shortly after midnight. The next day the iodine-131 activity decreased to 8% of its maximum value and 15 days after the accident (10 May), it was 440 times lower than the highest measured value.

Time profiles of various radionuclides in the air filters sampled in Seibersdorf and in Vienna are comparable, although the absolute amount of the measured activities differs. The increase of activity observed in Seibersdorf on 4 May 1986 (8 days after the accident)

Radioactivity of air filter samples collected at the Agency's laboratories in Seibersdorf.



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* The IAEA Seibersdorf Laboratory, located 35 kilometres south of Vienna in Lower Austria, comprises several specialized laboratories.

was also noted at the VIC at the same time. The second slight increase in total air activity also was observed simultaneously at both locations on 7 May 1986. (See figures on page 23 and 25.)

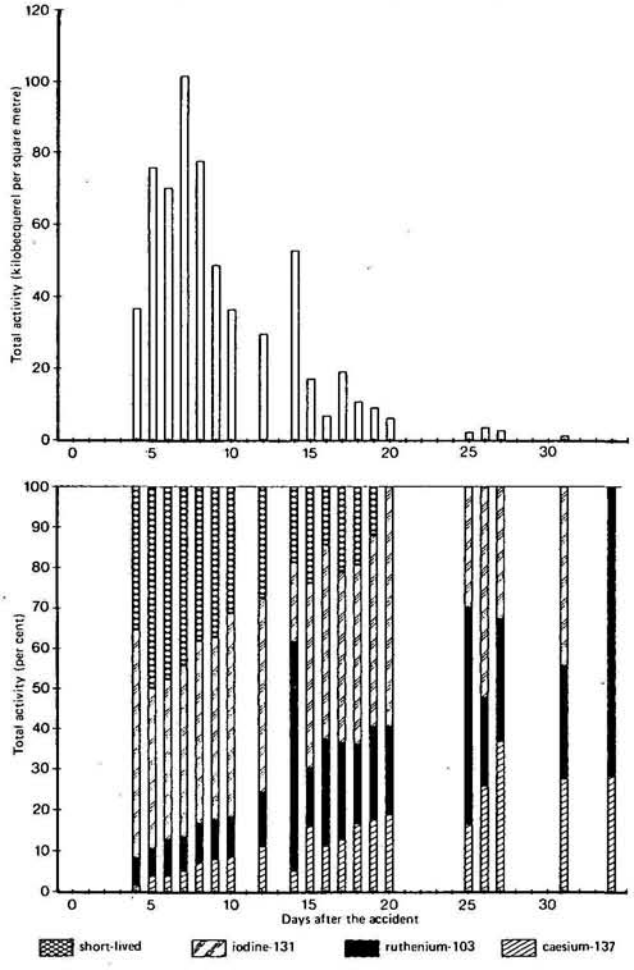
Grass samples

A significant increase of aerosol activity in Vienna was first reported between 11:40 a.m. and 2:25 p.m. on 29 April 1986. Radioactivity above background level was measured in grass samples collected on the same day at 5 p.m., i.e. 3.5 days after the accident. At Seibersdorf, a maximum of 88.4 kilobecquerel per square metre was measured in a grass sample collected 24 hours later. The gamma activity was mainly derived from iodine-131, iodine-132, tellurium-132, ruthenium-103, and caesium-137. (Similar procedures were followed and equal areas were used in the collection of samples in order to make significant comparisons.) The activity of caesium-134 in the samples was also measured. The ratio of the activities of caesium-137/caesium-134 of both sampling areas was approximately two for all cases. The activity pattern observed in samples collected in Vienna is not similar to the ones collected near Seibersdorf, even if the high activity of ruthenium-103, measured 14 days after the accident and caused by a "hot particle", is neglected. It is possible that, due to weather conditions (rain, wind, temperature), the radioactivity adhering to the grass was either transferred to surface soil or that volatile radionuclides such as iodine were released. Variations of activity patterns as a function of time are probably attributable to differences in meteorological conditions at the two sampling areas, which are at a distance of 60 kilometres from each other in direction north-south.

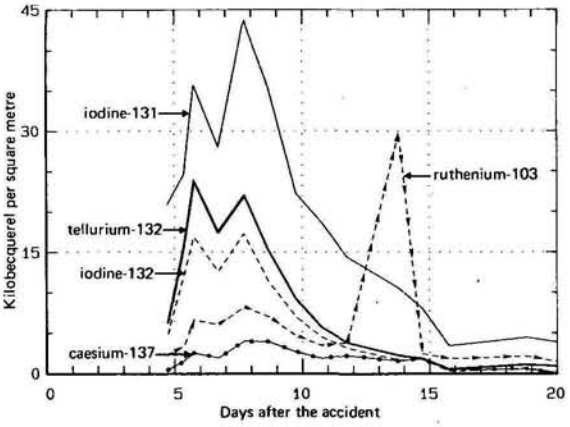
From the data of grass samples collected in Vienna, indicators are that a maximum total activity of 102 kilobecquerel per square metre was measured on 3 May 1986. This value declined to about 1.5 kilobecquerel per square metre 31 days after the accident. It can also be observed that, whereas the fractions of ruthenium-103 and caesium-134/caesium-137 contributing to the overall activity are increasing with time, the contribution of iodine-131 remains approximately constant. Similar activity distributions have been obtained from grass samples originating in the vicinity of the Agency's laboratories in Lower Austria.

However, it is noteworthy that the increase in total activity measured 14 days after the accident can be

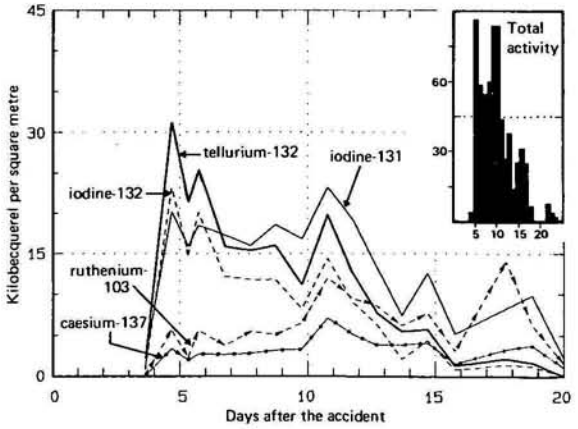
Contribution of selected radionuclides to the total gamma radioactivity of grass samples collected in Vienna.



Radioactivity of grass samples collected in Vienna.



Radioactivity of grass samples collected in the vicinity of the Agency's laboratories in Seibersdorf.



attributed to a "hot particle", which proved to mainly consist of ruthenium-103.

The activity of strontium-90 in grass samples collected three days after the accident in the vicinity of the Agency's laboratories was lower than the detectable limit. Samples collected later contained strontium-90 activities which were approximately 10 times higher than the background values. These strontium-90 activities represent about 1% of the caesium-137 activity measured in the same samples.

Soil measurements

Surface soil (from zero to two centimetres) from the Agency's laboratory area was collected on 6 May 1986 for gamma spectrometric measurements. (The results are given in an accompanying table.) Samples from the same area collected at a depth below two centimetres did not show any significant artificial radioactivity.

Some measurements performed on soil samples collected in different Austrian regions also were reported. These data also indicate the inhomogeneous surface distribution of the fallout deposits. Radionuclide concentrations found in soils collected in Upper Austria are at least one order of magnitude higher than those

Radioactivity of a surface soil sample collected in the vicinity of the Agency's laboratories in Seibersdorf (kilobecquerel per square metre)

Radionuclide	Activity
Tellurium-132	2.2
Iodine-132	2.3
Iodine-131	5.7
Ruthenium-103	1.3
Caesium-137	1.1
Caesium-134	0.5
Barium-140	0.5
Molybdenum-99	n.d.

n.d. = not detected.

Radioactivity of rainwater samples from different areas of Austria (kilobecquerel per litre)

Sampling date (1986)	29-30 April	30 April-1 May	8 May	8 May
	Burgenland	Vienna	Burgenland	Agency's Laboratory in Seibersdorf
Tellurium-132	35.2	19.2	n.s.	0.2
Iodine-132	28.8	17.5	0.4	0.3
Iodine-131	31.2	28.1	0.3	0.7
Ruthenium-103	6.4	5.5	0.2	0.4
Caesium-137	2.5	0.8	0.2	0.1
Caesium-134	1.6	0.3	n.d.	n.d.
Barium-140	0.3	0.5	n.s.	n.s.
Molybdenum-99	0.3	1.3	n.d.	n.d.
Total	106.3	73.2	1.1	1.7

n.s. = not significant. n.d. = not detected.

Note: Shown are results of gamma spectrometric measurements of unfiltered samples.

Radioactivity of air filter samples collected at the Vienna International Centre (becquerel per cubic metre)

	Date of sampling (1986)				
	5 March	5 April	5 May	5 June	5 July
Radionuclide					
Tellurium-132	0.8	4.5	1.1	0.2	0.6
Iodine-132	0.6	3.5	0.8	0.2	0.5
Iodine-131	0.7	1.2	0.4	0.2	0.3
Ruthenium-103	0.2	1.9	0.6	0.2	0.6
Caesium-137	0.3	0.8	0.3	0.09	0.2
Barium-140	0.1	0.9	0.2	0.04	0.06
Molybdenum-99 (Technetium-99m)	0.06	0.3	0.06	0.02	0.04
Total	2.76	13.1	3.46	0.95	2.30

Radioactivity of soil samples from different areas of Austria (kilobecquerel per kilogram)

Sampling place and date (1986)		I-131	Ru-103	Cs-137	Cs-134
Upper Austria	10 June	0.48	1.67	1.14	0.52
	11 June	1.23	3.92	2.94	1.35
	11 June	1.16	7.44	9.28	4.56
Burgenland (field)	18 June	0.03	0.22	0.39	0.19
(garden)	18 June	0.03	0.18	0.33	0.13
Lower Austria	23 June	0.01	0.13	0.17	<0.10

Strontium-90 activity of grass samples of different origin (becquerel per square metre)

	Date of sampling (1986)				
	29 April	30 April	1 May	2 May	3 May
Agency's laboratories	<3.0 <1.6	28	20	26	16
Vienna	—	—	40	18	12

measured in soils originating from Lower Austria and Burgenland.

Rainwater

No rainwater samples from areas surrounding the Agency's laboratories were available for measurements since precipitation during the relevant period was very low. However, some rainwater samples were collected in Burgenland and in Vienna, respectively, four and five days after the accident. No attempt was made to measure the fraction of dry deposits and its contribution to total activity.

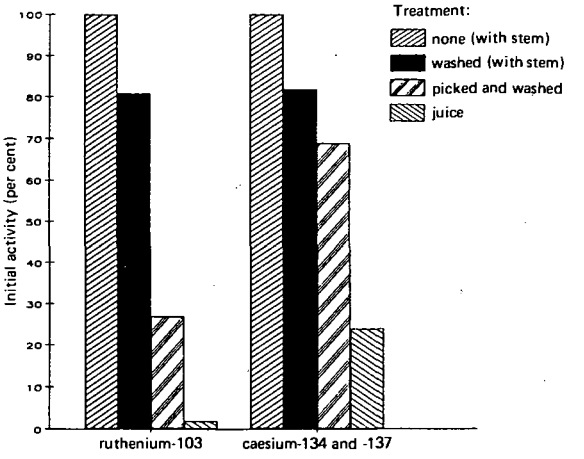
Results indicate that the total activity of samples collected on 8 May 1986, eight days after the first sampling, had decreased by almost two orders of magnitude. (See table, page 25.)

Tests of fresh fruit

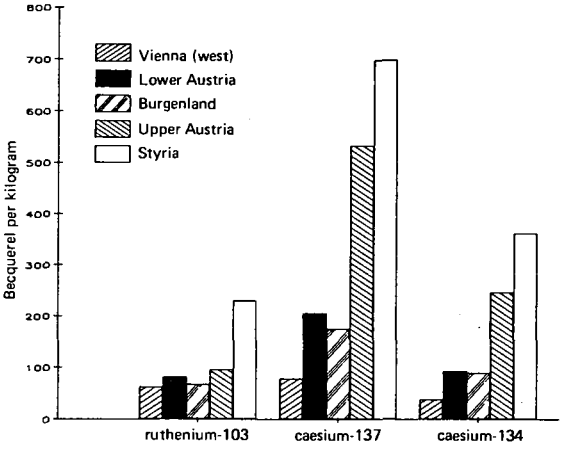
Measurements were made of fresh fruit harvested in different parts of Austria. The caesium-134/caesium-137 activities measured in different samples of cherries and red currants varied by one order of magnitude. In the case of red currants this variation is probably due to the difference in geographical locations from where the fruit had been collected. The highest activities were found in berries originating from Upper Austria and Styria. These findings point out that the amount and composition of fallout debris at a specific site is considerably influenced by the prevailing weather conditions.

In Austria, the maximum tolerable level for caesium-134/caesium-137 in fresh fruit is limited to 111 becquerel per kilogram (3 nanocuries per kilogram); it appears that 80% of the measured samples exceeded this limit. However, after cleaning and washing of the fruit, the activities were reduced to values near or below the tolerable levels for almost all samples. (See accompanying figures.) For caesium-134/caesium-137, the reduction was about 30% and for ruthenium-103, 75%. In the juice obtained from the same fruit, only 20% of the initial radioactivity of caesium was found and the ruthenium-103 contamination was almost removed. In mushroom cultures, no artificial radioactivity was detected. Field champignons and mixed mushrooms contained mainly caesium-137 with radioactivity ranging from 6 to 130 becquerel per kilogram wet mass. Cleaning and washing of mushrooms also considerably decreased radioactivity levels. Because of the elapsed time, iodine-131 (half-life: 8.5 days) was not detected in any of these samples.

Reduction of radioactivity of red currants by washing and cleaning.



Radioactivity of red currants related to geographical distribution.



Radioactivity of fresh fruit from different areas (harvest and measurements: June 1986 in becquerel per kilogram)

Fruit species	No. of samples	Ru-103	Cs-137	Cs-134
Strawberries	2	n.d.-8	11-12	n.d.
Cherries	5	n.d.	30-330	n.d.-160
Red currants (with stem)	8	63-230	79-700	39-360
Raspberries	1	n.d.	540	260
Blueberries*	2	n.d.-14	220-330	110-170
Goose berries	1	80	270	130
Mixed fruit (cherries, red currants, apricot)	1	120	150	76

n.d. = not detected.

* In addition, the radionuclides zirconium-95, niobium-95, cerium-141, and cerium-144 have been identified with activities of 116, 122, 38, and 94 becquerel per kilogram, respectively.