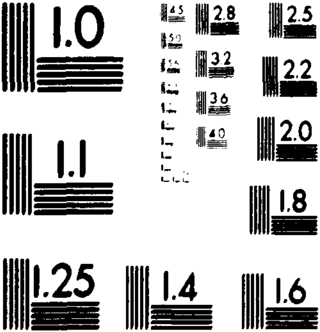


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

ISSN/0393-3016

ENEA

COMITATO NAZIONALE PER LA RICERCA E PER LO SVILUPPO
DELL'ENERGIA NUCLEARE E DELLE ENERGIE ALTERNATIVE

CHERNOBYL RADIOLOGICAL DATA FOR ACCIDENT CONSEQUENCE ASSESSMENT (BEHAVIOUR IN RURAL AREAS)

A. BOTTINO, A. SACRIPANTI
ENEA - Direzione Sicurezza Nucleare e Protezione Sanitaria
Divisione siti e controlli ambientali, Roma - EUR

ENEA - RT/DISP/89/2

Testo pervenuto nell'aprile 1989
Progetto Enea: Attività pubbliche di controllo (HA)

A B S T R A C T

In this draft is presented the result of a first effort to summarize information related to the radionuclides behaviour in rural areas, in order to estimate pathway parameters to assess accident consequences.

This topic ecnloses relevant aspects concerning contamination of rural environment, the most important being:

1. dry deposition velocities
2. washout coefficient
3. accumulation in lakes
4. migration in soil
5. winter conditions
6. filtering effects of forests

R I A S S U N T O

In questo lavoro si presenta il risultato di un primo sforzo volto a sintetizzare le informazioni sul comportamento dei radionuclidi in aree rurali, in modo da poter estimare i parametri relativi alle vie di trasferimento per la valutazione delle conseguenze indicentali.

Le informazioni, riferentesi alla contaminazione dell'ambiente rurale, sono relative ai seguenti aspetti:

1. Velocità di deposizione secca
2. Coefficienti di washout
3. Accumulo nei laghi
4. Migrazione nei suoli
5. Condizioni invernali
6. Effetto ".filtro" delle foreste.

INTRODUCTION

In this draft is presented the result of a first effort to summarize information related to the radionuclides behaviour in rural areas, in order to estimate pathway parameters to assess accident consequences.

This topic encloses relevant aspects concerning contamination of rural environment, the most important being:

1) dry deposition velocities
2) washout coefficient
3) accumulation in lakes
4) migration in soil
5) winter conditions
6) filtering effects of forests.

First of all, the authors wish to say that the work carried out up to now is to be considered as a first effort to face the problem of collecting, analyzing, and reporting data and information about all the topics concerned coming from different countries.

It must be also kept in mind that although a couple of years has already gone since the Chernobyl accident, some sort of measurements is time consuming, and a lot of activities are still in progress, so that other data and results will be available into the future. This is particularly so far istance for soil migration data.

It must be also considered that, despite the huge quantity of data collected with reference to the Chernobyl fallout in all Europe and outside, most of them have been carried out from a health physicists point of view so that it is now not an easy matter to extract from them information to be correlated directly to relevant parameters.

DRY DEPOSITION VELOCITY

DRY DEPOSITION VELOCITY

Dry deposition has been measured in a number of countries, new estimates of dry deposition velocities following the Chernobyl fallout have been carried out mainly in Swiss, in United Kingdom and in Sweden.

In the tables (2-3), results have been summarized according to the authors and the most relevant nuclides. More detailed informations may be found into the original papers. In particular the paper of Santschi determines in addition the scavenging factor for corresponding nuclides which are reported in the following table (1) and which refer to the rainfull period of 30 April with precipitation rate of about 5-10 mm/sec. According to the authors, values for all measured nuclides are about 400 (except Sr-89:Sr-90: about 700) which is to be expected for particles of 0.5-1.0 mm diometer.

TABLE 1 - Scavenging Verhältnis S ($S = C_{Regen} . p / C_{Luft}$, mitp = 1.2 kg/m^3

Nuklid	S(30.4-1.5)	C_{Regen} (rain) (Bq/kg)	C_{Luft} (air) (Bq/m^3)
Ba-140	440 ± 40	286 ± 14	0.78 ± 0.06
Cs-137	371 ± 20	448 ± 18	1.45 ± 0.04
I-131	410 ± 25	3430 ± 6	(2.01 ± 0.11)x5*)
Ru-103	327 ± 15	592 ± 4	2.17 ± 0.08
Te-132	412 ± 50	3160 ± 5	9.21 ± 1.06
Sr-89**)	716 ± 86	76 ± 6	0.12 ± 0.01
Sr-90**)	657 ± 112	3.8 ± 0.5	0.0064 ± 0.0005

*) Annahme: C_{Luft}(total) = 5 x C_{Luft}(Filter), siehe Text.
**) Berechnet aus den Sr-89/Cs-137 und Sr-90/Cs-137-Verhätnissn entsprechender Proben

Dry deposition velocities have been masured on grass in the Dübendarg area with fog and without fog for various aerosols.

Values reported by S. Nair, which appear to be rather high, have been communicated privately.

Data presented by Cambray et al., are part of a large study were other topics are also coped including dose estimates and source estimation. As far as regards dry deposition velocity, reported for Cs-137 on the ground around Chilton (0.03 cm/sec), according to the authors, turns out to be an order of magnitude smaller than the value commonly used in accident studies.

Data reported for Sweden, have been derived from a specific study carried out by STUDVIK on dry deposition velocities on grass.

In the table 2 we present the mean values corresponding to different localities in Sweden by Appelgreen (1) and all the values derived by Cambray (2) Nair (3) and Santschi (4). In the following table (3) the particular values for each sampling point in Sweden, during the 04-28-86 to 04-20-86, are presented.

TABLE 3 - Dry deposition velocities on grass (m/s) during the period 86-04-28—86-04-30. No corrections are made for other processes than radioactive decay

	Station a)						
Nuclide	Studsvik A	Studsvik B	Tranvik A	Tranvik B	Byggninge	Horsvik	Mean
Ru-103	5.8E-3		1.0E-2		4.4E-3	3.3E-3	5.9E-3
I-131 b)	1.7E-2	1.9E-2	3.7E-2	2.7E-2	2.0E-2	9.9E-3	2.3E-2
I-131 c)	5.4E-3	5.6E-3	1.1E-2	1.1E-2	6.2E-3	3.0E-3	
Cs-134	9.4E-4		2.5E-3		1.3E-3	5.7E-4	1.3E-3
Cs-137	1.7E-3	1.1E-3	2.2E-3	2.3E-3	1.1E-3	5.5E-4	1.5E-3
Ce-141	6.9E-3		4.8E-2			9.8E-3	2.2E-3
Np-239	5.4E-3		3.2E-2		2.9E-3		1.3E-3

a) At some of the stations two grass samples were taken and therefore they are identified as A and B

b) Particulate

c) Corrected for 70 % in gaseous form

Table 2 - Dry deposition m/sec

Nuclide / Author	I-131 I-132 Te-132	Ce-KI	Np-239	Cs-134	Cs-137	Ru-103	Notes
(4) Santschi Swiss					2E-4	8E-4	with fog
	2-5E-3				1E-3	2.3E-3	without fog
Nair (3) UK	2.6E-3				1.5E-2	1.3E-2	
Cambray (2) UK	I-131 1.1-3.3E-3 I-132 4.8E-4			5.1E-4 1.4E-3	4.4E-4		
Appelgreen (1) Sweden	I-131 2.3E-2	2.2E-3	1.3E-3	1.3E-3	1.5E-3	1E-2	

WASHOUT COEFFICIENT

WASHOUT COEFFICIENT

On this subject, the contribution provided by R.S. Cambray et al. (2), entitled "Observations on radioactivity from the Chernobyl accident", published in "Nuclear Energy in 1987, allows a direct estimation of the washout coefficient.

In this paper washout coefficient has been defined as

$$W = \frac{\text{activity per unit mass of rain}}{\text{activity per unit mass of air}}$$

Despite the distinction between rain-out, and the fact that both contribute, the ratio W is called the wash-out ratio.

W is usually calculated from observations made at ground level.

Table 4 - Values of the wash-out ratio W for radionuclides from Chernobyl, determinated at Chilton

Date	Cs-137	Cs-134	I-131	I-132	La-140
3-4 May	6100	6900	58000	45000	4300
4-5 May	11000		7300		
5-7 May	6600		2350		
7-8 May	6800		2950		
8-9 May	1600		2600		
9-10 May	23000		12000		
11-12 May	3800	3900	1800		
14-15 May	400		830		
19-20 May	270		600		
22-23 May	230		2200		

These estimates of W must be treated with caution for the following reasons.

a) As the airborne concentration was so much higher on 2-3 May, much of the activity in the rain sample collected on 2-3 May may have been from dry deposition.

b) During the first half of May the airborne concentrations were varying very rapidly. Even from the daily samples considered, the air concentrations recorded may not be representative of those during the period of rain.

Despite these reservations, some generalizations can be drawn from the results. The wash-out ratios for caesium isotopes, I-131 and La-140 are similar, were initially of the order of a few thousand but did not exceed a few hundred in the second half of the month. (The high value for I-131 on 3-4 May may have been influenced particularly strongly by dry deposition on the previous day). The great variability in the results may reflect variations in the vertical distribution of radionuclides in the atmosphere as well as the processes causing scavenging by rain.

An alternative estimate of the wash-out ratio can be made from the decay rate of the air concentration of Cs-137 from about 20 May onwards. Assuming that wash-out is the principal removal mechanism and that the active material was then well mixed throughout a defined volume, such as the northern troposphere, the wash-out ratio (now defined in terms of the mean concentrations in rain and in air throughout that volume) and the mean residence time T are related by

$$T = m/rW$$

where m is the mass of air per unit area (about 9000 kg/m^2 assuming mixing up to the tropopause) and r is the mean rate of rainfall. With 7 days as the value of T estimated from the data and deducing a value of 92 mm/month or 3.1 mm/day for the mean northern hemispheric precipitation rate for May to July from Staley:

$$W = \frac{9000}{3.1 \times 7} = 410$$

Any systematic difference between the values in Table 4 and this value could be ascribed chiefly to the difference between ground level and volume mean air concentrations, and to spatial variability in the mechanisms of precipitation scavenging and hence in W.

The wash-out ratios observed at ground level in the UK for the early weapon tests, which were believed to inject activity only into the troposphere, were found to be in the range 500-800, while the mean residence time of about 20 days deduced from observation of air concentration would, on this argument, imply a value of only 150. It is not clear why the surface and global approach should give such a great difference in the answers for weapons fall-out unless some fraction of the fall-out had entered the low stratosphere, to maintain an extended atmospheric residence time by slow stratospheric - tropospheric exchange. Such a complication should not enter a comparison with the wash-out of Pb-210, a radionuclide formed in the troposphere by the decay of the radon emitted from land surfaces.

19/20

ACCUMULATION IN LAKES

Accumulation in lakes

Up to now specific data concerning this topics are not available.

A study on accumulation in rivers and lakes is presently being on at CERN (5) including masurements of surface water and related subjects.

MIGRATION IN SOIL

MIGRATION INTO THE SOIL

A recent paper, by W.R. Schell et al. (6), presented at the "IV international Symposium of Radioecology" held in Cadarache, entitled "Racycling and removal of Radionuclides in forest soil resulting from nuclear accidents" deals with migration into the soil of Cs-137 in connection with the old fallout caused by the nuclear weapons tests and with the recent Chernobyl fallout.

Post Chernobyl measurements are reported referring to Pennsylvania soil samples and to samples collected in different parts of Japan. Other studies are also in progress.

27/28

WINTER CONDITIONS

WINTER CONDITIONS

Some seasonal aspects related to deposition have also been pointed out. In a private communication (7) coming from the institut for energy technology (Norway) it has been noted a different behaviour between Cs-137, Cs-134 and I-131 occurring with snow melting.

Some measurements in precipitations and in melting waters in the river Atna (Norway) during period of Chernobyl fall-out has been carried out. Table (5) shows the content of various nuclides in precipitation collected in two different locations (Gamlegarden and Sør-Nesset) over the time period 22 April to 7 May. The two locations are 15 km apart, and both at roughly 700 m height above sea level. The contamination levels are quite similar, and may indicate that deposition over the area was reasonably uniform. Figure 1 shows in A the water volume (m^3/s) draining out of the area at the dates indicated at the bottom line; part B shows radiocesium in the water (Bq/l) in the same position, and part C shows I-131. The interesting aspects are that iodine is washed out of the area very soon after deposition; while the largest amounts of cesium comes with the early part of the bulk of the melt water from about 3 May. The peaks around 6 May might reflect arrival of the second (although smaller) part of the release that was observed in other parts of Norway during the period 5 to 9 May. Comparison of the precipitation and drainage data indicates that about 10% of the cesium deposited in the area ran off with the melting water.

Table 5 - Spesifikk aktivitet (Bq/l) i nedbørprøver fra Camlegarden of Sør-Nesset fra perioden 22.4 til 7.5.1986

	Camlegarden	Sør-Nesset
I-131	11665	10656
Ba-140	315	271
Cs-134	1085	946
Cs-137	1869	1737

In addition a particular study has been carried out by P.A. Cawse et al. (8) entitled "Comparison of radionuclide deposition to soil and vegetation", were specific information may be found on the seasonal deposition of Cs-134, Cs-137, Pu-238,240 and other nuclides in different locations spread over UK and France.

The ratios of winter/summer atmospheric deposition ('86-'87) are reported in the following table (6); for the details the original paper should be addressed.

Fig. 1 - Vannføringen (M3/s) ut av feltet (vm 2316) ved hver prøvetaking (A) of spesifikk aktivitet av Cs-isotoper (B) of I-131 (C) i vannprøver tatt samme sted

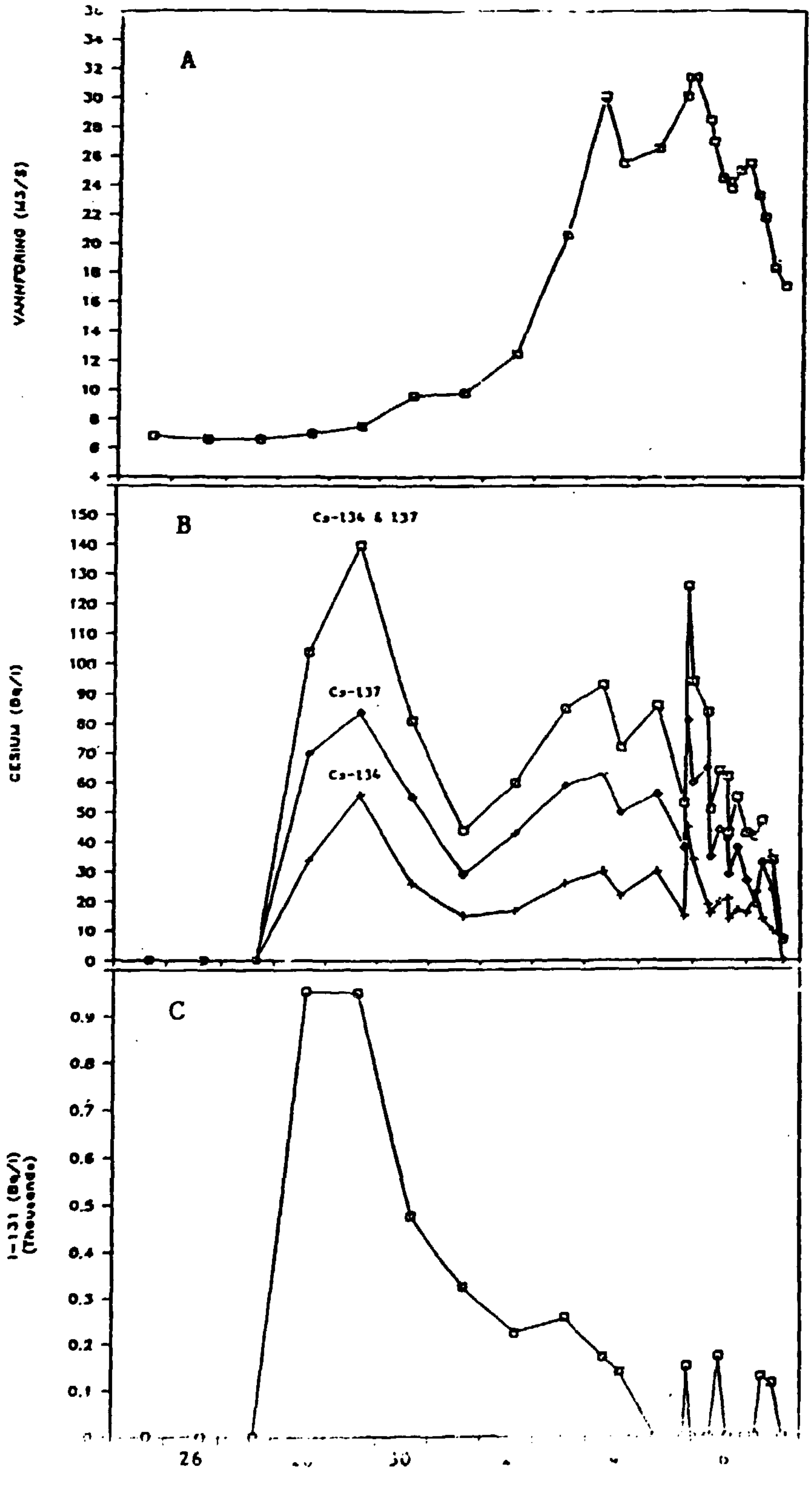


Table 6 - Ratios of winter/summer atmospheric deposition of radionuclides 1986/87

Site no.	Field plot	Winter/summer Deposition* of Radionuclides Cs-134	Cs-137	Pu-239+240	Am-241	Sr-90	Na	Ti
	Locations in Britain							
1	DOUNREAY	0.20	0.25	1.0	0.95	0.34	7.8	3.9
2	HUNA	0.25	0.30	0.2	1.1	0.42	12.2	8.5
3	BRAYSTONES	0.032	0.068	6.8	3.7	4.5	11.2	5.0
4	PENRITH	0.11	0.12	4.0	2.4	0.29	2.1	3.4
5	TRAWSFYNYDD	0.41	0.53	2.6	0.90	0.69	5.0	4.6
6	BALA	0.19	0.26	ND	2.9	0.05	5.1	2.8
7	CHILTON	ND	0.98	0.87	0.23	1.0	10.8	3.6
8	ASHBURY	0.41	0.64	0.4	0.7	0.30	7.8	7.6
9	WINFRITH	ND	0.18	5.9	0.23	0.20	5.5	1.2
10	CORFE	0.3	1.1	1.3	1	1.1	4.9	0.61
10a	S.BRENT	0.3	0.15	1.9	3.4	0.4	7.6	1.4
	Location in France							
11	MARTINVAST	ND	2.5	1.1		Not	2.4	
12	MERQUETOT	ND	4.2	2.0			3.1	
13	DAMPIERRE	ND	2.0	2.8		A	1.5	
14	LION en SULLIAS	ND	1.9	3.3		n	2.1	
15	MORESTEL	0.8	0.40	5.1		a	0.78	
16	MONTALIEU	0.8	0.64	3.9		l	1.7	
17	CADEROUSSE	ND	7.5	2.3		y	1.9	
18	ST.ETIENNE des SORTS	ND	8.4	3.1		s e	2.3	
						d		

Note: (i) *winter 1986-87 / summer 1986

(ii) ND denotes that results for both seasons were below limit of detection

(iii) Odd numbers denote sites near to nuclear installations
Even numbers denote sites distant from nuclear installations

FILTERING EFFECTS OF FORESTS

FILTERING EFFECTS OF FORESTS

On this subject three major papers have been examined:

- the first one (9) by C. Ronneau et al., published in Atmospheric Environment in 1987 entitled "The deposition of radionuclides from Chernobyl to a forest in Belgium";
- the second one (13) by E. Henrich et al. presented at Cadarache in March 1988, entitled "Cs-137 in natural ecological systems - Description of the situation in a high contamination area in Austria after Chernobyl";
- the third one (12) by J. Roed, presented at Rome at the Joint CEC/OECD Workshop in January 1988, entitled "The distribution of dry deposited material on trees from the Chernobyl accident".

In the first paper measurements data have been reported on deposition in a spruce forest located near the town of Vielsalm, at an altitude of about 540-560 m.

Two sets of results are presented referring to bulk and dry deposition and each one has been collected in either clearing location either beneath canopies.

The major findings are shown in the two following table 7 - 8

Table 7 - Mean deposition of radionuclides to the forest of Vielsalm: in clearings (CL) and under canopy (CAN)

	Deposition (Bq/m^{-2})			
	Bulk		Dry	
Radionuclide	CL	CAN	CL	CAN
R-103	1670	1330	70	35
I-131	4320	4590	870	640
I-132	5650	7140	/	/
Te-132	5960	7960	170	120
Cs-134	720	140	34	30
Cs-136	170	40	/	/
Cs-137	1320	280	160	130
La-140	214	160	138	100

Table 8 - Ratio of deposited activities under canopy and in clearings

Radionuclide	Depos.CAN/Depos.CL
R-103	0.80
I-131	0.94
I-132	1.26
Te-132	1.34
Cs-134	0.19
Cs-136	0.24
Cs-137	0.21
La-140	0.75

According to the author's discussion it has been found that the "filtering effect" of trees as for as dry deposition is concerned, ranges between 10% and 50% which is in agreement with values observed for other pollulants.

It has been also found that bulk deposition under conopies and in Clearings are about equal during rainy periods; on the contrary following a long dry period a subsequent slight rain scavenges more pollulant under conopies.

Table 8 presents the ratios of radionuclides collected the 14 May 1986, under trees and in clearings; it can be seen that ratios are close to unity, indicating a prevailing action of rain, with the cospicuous exception of Cs which is very much less deposited under trees.

The other two papers both referring to spruce forests are mainly interested in analyzing the vertical distribution of radioactivity on the trees and on different parties (needles, wood, bark).

The results are refering to a few samples but any-way some preliminary informations may be derived about the distribution as in figg. 3, 4 and in tables 9+12.

Table 9 - Deposited Material on Branches, Twigs and Needles of Common Spruce in Bq per kg of (branches, twigs, and needles). Tree no. 1

Height	cm	0-75	75-135	135-215	215-315	315-405	405-472	472-545	545-654	mean 0-654
Be-7	Bq/kg	7.4	6.5	6.6	6.6	8.1	7.5	10.4	4.9	7.3
Nb-95	"	22.8	57.7	32.6	16.5	39.7	34.8	27.3	39.4	33.9
Zr-95	"	12.3	30.0	20.6	9.8	24.8	20.3	15.8	22.6	19.5
Ru-103	"	-	-	-	-	-	-	-	-	-
Ru-106	"	0.84	3.7	1.8	2.8	1.6	3.4	3.4	4.9	2.7
I-131	"	266.7	181.0	162.4	173.4	-	121.7	229.6	72.8	172.5
Cs-134	"	1.1	1.2	1.2	1.9	1.5	1.5	2.1	1.8	1.5
Cs-137	"	3.1	3.0	2.5	4.2	3.7	3.3	4.6	4.6	3.6
Ce-141	"	9.1	24.0	30.1	13.3	20.5	26.0	22.5	20.2	20.7
Ce-144	"	6.0	18.2	14.4	8.5	14.4	18.0	16.8	10.4	13.3
Eu-152	"	-	-	-	0.32	-	0.11	0.24	0.25	0.23
Eu-154	"	0.052	0.25	0.10	0.14	0.30	0.06	0.059	0.43	0.17

Table 10 - Deposited Material on Branches, Twigs and Needles of Common Spruce with Height in bq per kg (Branches, Twigs and Needles)
Tree no. 2

Height of tree	cm	0-125	125-275	275-390	390-610	mean 0-610
Be-7	Bq/kg	10.9	11.5	8.1	13.2	11.0
Nb-95	"	57.9	88.7	22.9	57.3	56.7
Zr-95	"	39.5	33.1	13.9	36.2	30.7
Ru-103	"	-	-	-	-	-
Ru-106	"	3.5	4.4	-	4.1	4.0
I-131	"	114.0	115.8	174.0	186.4	147.6
Cs-134	"	1.4	2.1	1.8	3.0	2.1
Cs-137	"	3.0	5.0	3.9	6.8	4.7
Ce-141	"	33.0	29.4	12.7	40.4	28.9
Ce-144	"	21.0	21.1	10.3	26.0	19.6
Eu-152	"	0.55	0.33	0.067	0.45	0.35
Eu-154	"	0.12	0.25	0.48	0.19	0.26

Table 11 - Deposited Material on Cortex of Common Spruce with Height in Bq per m^2 of Cortex
Tree no. 2

Height of tree	cm	0-125	125-275	275-390	390-610	mean 0-610
Be-7	Bq/m^2	4.4	3.1	8.3	20.0	9.0
Nb-95	"	0.91	20.7	14.4	-	12.0
Zr-95	"	1.2	12.5	8.3	0.39	5.6
Ru-103	"	0.59	2.7	1.6	1.2	1.5
Ru-106	"	0.32	0.21	0.42	2.1	0.76
I-131	"	678.1	[illegible]33.4	139.9	54.6	291.5
Cs-134	"	0.28	0.37	0.046	0.47	0.29
Cs-137	"	1.0	1.2	0.82	1.3	1.1
Ce-141	"	-	5.9	1.2	3.3	3.5
Ce-144	"	0.32	4.7	4.5	1.5	2.8
Eu-152	"	-	-	-	0.72	0.72
Eu-154	"	0.17	0.21	1.0	0.29	0.42

Table 12 - Deposited Material on Cortex of Common Spruce with Height in Bq per m^2 of Cortex.
Tree no. 1

Height	cm	0-75	75-135	135-215	215-315	315-405	405-472	472-545	545-654	mean 0-654
Be-7	Bq/m^2	5.5	8.3	8.4	6.1	8.9	9.4	8.5	23.1	9.8
Nb-95	"	29.4	1.4	0.78	0.68	-	3.9	2.9	20.9	8.6
Zr-95	"	21.2	1.9	0.66	0.61	-	1.9	4.5	13.1	6.3
Ru-103	"	8.8	0.67	0.71	0.88	7.2	1.7	2.0	4.6	3.3
Ru-106	"	3.8	0.016	1.5	0.53	-	0.52	-	1.3	1.3
I-131	"	55.3	50.7	56.9	50.0	-	-	2284.3	1675.0	695.4
Cs-134	"	0.68	0.26	0.069	0.22	0.25	-	(0.074)	0.53	0.30
Cs-137	"	1.9	1.1	1.1	1.0	0.83	0.47	0.25	1.5	1.0
Ce-141	"	17.0	0.47	-	-	2.1	-	-	7.1	6.7
Ce-144	"	12.1	1.0	0.54	-	-	2.0	-	7.0	4.5
Eu-152	"	0.20	-	-	0.050	-	-	-	-	0.13
Eu-154	"	0.42	0.44	0.66	0.47	-	0.74	0.59	0.28	0.51

Studies on physico-chemical beaviour of radiocaesium in forests, are also in progress with special laboratory experiments (Deposition of thermo generate caesium anto plant surfaces) by AL Rayyes et al. (10) in Belgium.

AL Rayyes et Al. "Deposition of thermo-generated Caesium onto plant surfaces - Physico-Chemical study of the aerosol".

Particulally in one other paper by Ranneau et Al. (11) "Contaminations des ecosystemes foresties par le cesium" data are reported on contamination of trees bark according to the geografical orientation.

41/42

MISCELLANEA

MISCELLANEA

- Halflife into grass for Cs-137-134 and I-131.

It has been shown (R.S. Cambray), by several measurements of the grass that activity has decreased with a 14 day half life for Cs-137 and a 4.7 day halflife for I-131.

The latter result indicates that a physival removal process is operating with a half-life of 11 days, not significantly different from the removal rate for Cs-137.

- Interception factor, lichen.

The interception factor is strongly dependent upon previous weather conditions. If the lichen is quite dry, a rainfall of the order of 3 mm is soaked up entirely, and the interception factor is accordingly 1 (100%). Saturated lichen, on the other hand, does not absorb additional water, and the interception factor will approach zero.

- Uneven distribution of deposited materials.

It is found that activity per unit area often varies by factors from two to ten in points only a few meters apart. When there is a height difference also, one finds often that the deposition is higher on the ridge, which is unexpected. This was not dry deposition, so the effect can not be explained as some peculiarity of the deposition process near a ridge. The more palusible explanation is that moss and other vegetation on the ridge is drier, and accordingly soak up more of the precipitation. In other cases, however, no plausible explanation of sharp variations has been found.

ADDENDUM TO SURVAY OF CHERNOBYL DATA FOR ACCIDENT CONSEQUENCE ASSESSMENT (BEHAVIOUR IN RURAL AREAS)

Dry deposition velocities

In the paper presented by Mr. Roed at WOrkshop held at Roskilde 1987 on "Accidental Urban contamination" called "Dry deposition in rural and in urban areas in Denmark" it is possible to find many data concerning rural areas, forest and suburban trees. " The deposition velocity, however, was clearly different for the various isotopes. Particle-bound caesium had the smallest values, with a mean deposition velocity V_d of about 1 x 10^{-4} m.s.$^{-1}$. The next group consisting of particulate ruthenium, lanthanum, and elemental iodine had deposition velocities of around 5 x 10^{-4} m.s.$^{-1}$. The highest deposition velocity was found for particulate cerium and zirconium (10 x 10^{-4} m.s.$^{-1}$)."

" The values for bush and forest are higher because of the filtering effect of these types of surfaces.

The deposition velocities of other isotopes are 5-10 times higher than those of caesium, except for ruthenium.

The deposition velocity on grass seems to be proportional to the mass per unit area of surface." See Table 1, 2, 3, 4.

Table 1 - Deposition Velocities (Units: 10^{-4} m.s.$^{-1}$) for suburban trees and bushes

Isotope	Yew trees Height 2.5 m Sample n. 155	Yew trees Height 2.4 m Sample n. 156	Juniper berry Height 2 m Sample n. 153
Cs-134	13	5	3
I-131	110	100	32
Ce-141	63	30	23
Ce-144	69	23	28
La-140	33	30	14
Ru-103	36	28	13
Ru-106		47	28
Zr-95	78	32	26
Nb-95	84	31	26

Table 2 - Deposition velocities (units: 10^{-4} m.s.$^{-1}$) for soil

	Forest soil		Harrowed field soil			
Sample number						
Isotope	188	189	179	180	182	182.2
Ce-141	16	11	17	41	22	66
Zr-95	12	13		45	16	20
Nb-95	12		22	65	14	
I-131	15	44	27	15		

Table 3 - Deposition velocity in a forest: (units: 10^{-4} m.s.$^{-1}$)
40.5 trees per 100 m^2, average tree height = 7 m

Isotope	Common spruce
Cs-134	7.3
I-131	89
Ru-103	28
Ru-106	53

Table 4 - Deposition velocity V_d: 10^{-4} m.s.$^{-1}$, bulk deposition B_d 10^{-4} m^3.s^{-1}.kg^{-1}, for grass

Sample No.		Cs-137	Cs-134	I-131
1384	V_d	4.3	4.4	22
	B_d	21	21	110
1387	V_d	1.8	1.5	18
	B_d	10	8.7	100
1388	V_d	8.8	7.2	93
	B_d	10	8.5	110
1391	V_d	6.0	6.6	86
	B_d	7.9	8.7	110
1392	V_d	7.4	9.9	120
	B_d	9.1	12	140

Other data may be found in the paper "Measured deposition velocities and rainout coefficients after the Chernobyl accident compared with theoretical models and experimental data" presented at 7° IRPA congress in Australia 1988, by H. Bonka et al. (Aachen).

Accordin to the authors, deposition velocity of Cs-137 on grass range from 2.5 10^{-4} to 1.1. 10^{-3} m/s taking into account both extremely long and short grass, and, as for as regards Iodine (particle bound and gaseous species), deposition velocity ranges from 1.3 10^{-3} to 2.8 10^{-3} m/s.

REFERENCES

1) Appelgreen A. - "Dry Deposition velocities on grass at Studsvik after the Chernobyl Accident", part 1, 08-12-1986 - Studsvik - Technical Note.

2) Cambray R.S. et al. - "Observations on radioactivity from the Chernobyl accident" - Nucl. Energy, 1987, 26, n. 2.

3) Nair S. - Private communication - 04-30-1987.

4) Santschi P.H. t al. - "Messung der atmosphaerischen deposition von Tschernobyl - radionukliden (gesamt-und-trockendeposition) in raume duebendorf (ZH).

5) Rand G and Bonifas - "Chernobyl - A summary of measurements at CERN".

6) Schell W. et al. - "Recycling and removal of radionuclides in forest soil resulting from Nuclear Accidents" - IV Intern. Symposium Radioecology, 14-19 March 1988, Cadarache FR.

7) Tveten U. - Private communication - 05-06-1988

8) Cawse P.A. et al. - " Comparison of radionuclide deposition to soil and vegetation" - IV Inter. Symposium of Radioecology - 14-19 march 1988, Cadarache FR

9) Ronneau C. et al. - "The deposition of radionuclides from Chernobyl to a Forest in Belgium" - Arm. Environment, Vol. 21, n. 6, 1987.

10) AL Rayyes A.H. et Al. - "Deposition of thermo-generated caesium onto plant surfaces" - I Physico, Chemical study of the aerosols.

11) Ronneau C. et Al. - "Contamination des ecosystemes forestiers par le cesium"

12) Roed J. - "The distribution of dry deposited material on trees from the Chernobyl accident" - Joint CEC/NEA Workshop, 25-30 January 1988, Rome IT.

13) Henrich E. et Al - "Cs-137 in Natural Ecological Systems. Description of the situation in a Hig contamination area in Austria after Chernobyl" - IV Symposium of Radioecology, 14-19 March 1988, Cadarache FR, Papers received useful for the other brances of GRECA group.

14) Rauret G. et Al. - "Trasference factor of radiocaesium between the different compartments of a mediterranean forest and the relation between of radiocaesium and the organic matter content in soils".

15) Henrich E. - "Chernobyl - Its impact on Austria" - The science of the total Environment, 70, 1988.

16) Belli M. et Al. - "Indagini radioecologiche nella regione Friuli-Venezia Giulia primi risultati dell'indagine nell'ambiente agricolo della pianura friulana" - Doc.DISP/ARA/SCA(1987)2.

17) Belli M. et Al. - "First results of a radioecological research on the agricultural environment on the north-eastern region of Italy (Friuli-Venezia Giulia)" - Doc. DISP/ARA/SCA(1988)4.

18) Belli M. et Al. - "Evaluation of data on the transfer of radionuclides in foodchain" - Doc.DISP/ARA/SCA(1988)8.

19) "Der Unfall Chernobyl" - HSK-AN-1816, November 1986.

20) Nuffeler P. et Al. - "Messungen des radioktiven ausfalls vom reaktorungück in Tschernobyl an Korngrössenfraktioniertem Luftstanb und in der Deposition südlich fon Bern".

21) Czarnecki J. et Al. - "Bodenverstrahlung in der Schweiz aufgrund des reaktorunfalls in Chernobyl".

22) Surveys of Radioactivity 1984-1986 welsh office March 1988.

23) Henrich E. - "Radiocesium in austrian precipitation samples after Chernobyl" - Baluf-STS-87-8.

24) "The consequences of the Chernobyl nuclear accident in Greece" - Vol. I & II, 86/4 - 86/9.

25) Nair S. & Darly J. - "A preliminary assessment of individual doses in the environs of Berkelly, Gloucestershire, following the Chernobyl nuclear reactor accident" - J. Soc. Radiol. Prot. 6(3) 1986.

26) "Verstrahlungslage in der Schweiz nach dem unfall in Tschernobyl" - Bern, September 1986.

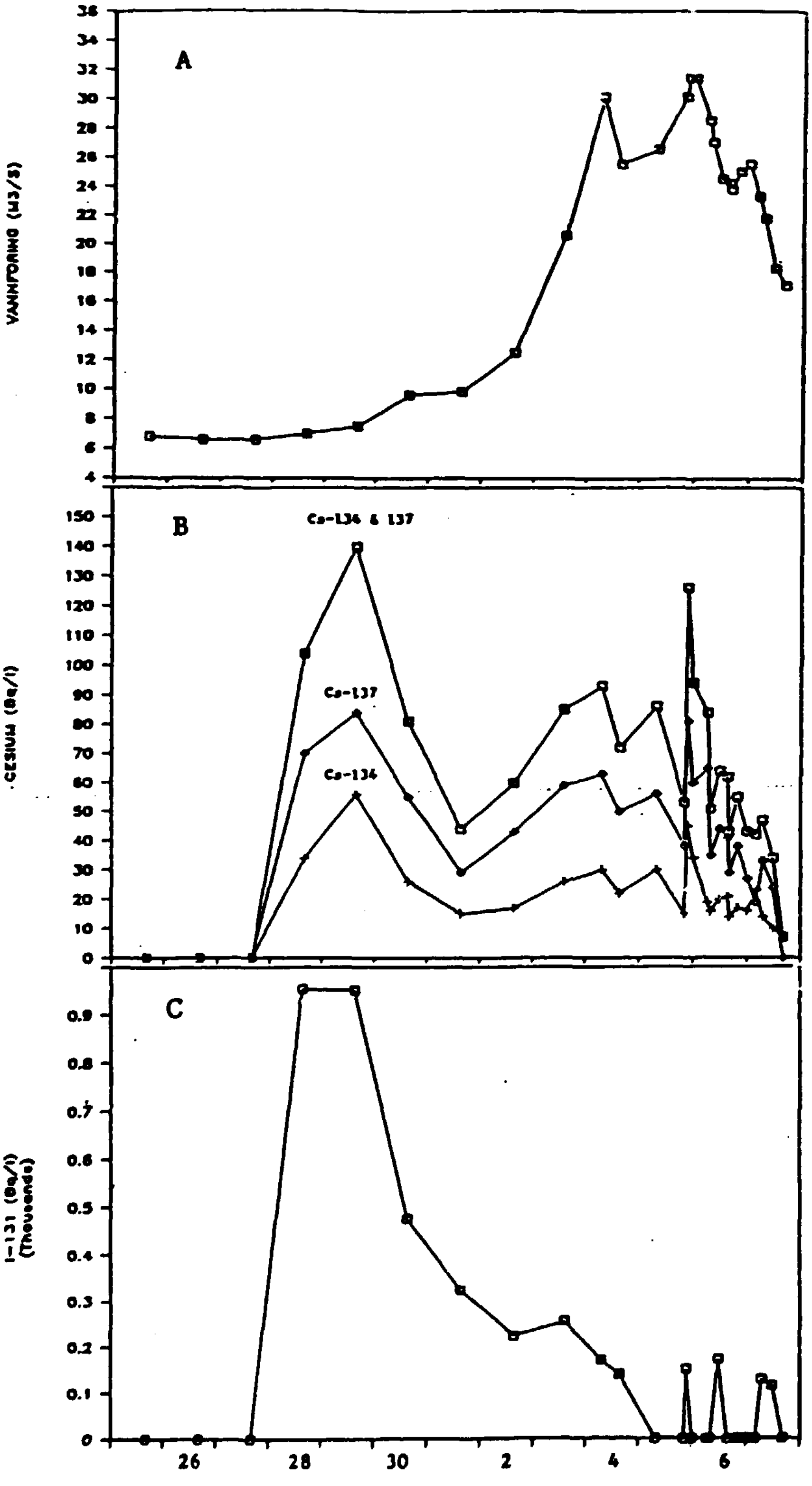
27) Maubert H. - "Suive de la radioactivite de l'herbe apres l'accident de Tchernobyl dans le bassin du Var Jauvier" - 1987.

28) Henrich. E - "Die radiktive belastung der Donau var und nach Tchernobyl" - Wasser und Abwasser, Band 31, 1987.

29) Surbek H. et Al. - "Alter, neuer und neuster fallout in boden der Schweiz".

30) Portmann W. et Al. - "Zeitliche und raeumliche veraenderung der isotopenverhaeltnisse im radioaktiven ausfall von Tschernobyl".

31) Gäggeler H. et Al. - "Falloutmessungen an grösenfraktionierten Aerosolen".



Figur 2. Vannføringen (m^3/s) ut av feltet (vm 2316) ved hver prøvetaking (A) og spesifikk aktivitet av Cs-isotoper (B) og I-131 (C) i vannprøver tatt samme sted.

Edito dall'ENEA, Direzione Centrale Relazioni.
Viale Regina Margherita, 125 - Roma
Finito di stampare in giugno 1989

Fotoriproduzione e stampa
a cura delle «Arti Grafiche S. Marcello»
Viale Regina Margherita, 176 - Roma

Questo fascicolo è stato stampato su carta riciclata

G 1335

90 01 06

AD 90 12

CAL 800