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IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

# INFORMATION REPORT

## Detection of an increase in airborne radioactivity levels in Northern Europe – Update of July 22, 2020

**Date** : 07/22/2020

**Since the publication of the IRSN information report of June 30, 2020, measurements available abroad have made it possible to model the transport of air masses in Western Europe and to determine a plausible geographic area of the release origin which is located on a territory covering part of the Baltic countries and Western Russia.**

**Measurements in France from the IRSN's OPERA monitoring network do not reveal the presence of radionuclides linked to this release.**

**Regarding the cause of the release, new measurements confirm that the radionuclides identified and their proportions are characteristic of irradiated nuclear fuel.**

**The simulations make it possible to estimate the exposures that could result from the release. These are low in the immediate vicinity of the point of release and insignificant at longer distance.**

# 1. AVAILABLE INFORMATION

As indicated in the IRSN information report of June 30, 2020, various artificial radionuclides were detected in June as reported by the Norwegian[1] (DSA), Swedish[2] (SSM) and Finnish[3] (STUK) authorities. As a reminder, traces of iodine-131 were measured during the first week of June 2020 in Norway. Subsequently, the Swedish and Finnish authorities reported that the following radionuclides had been detected by their monitoring stations from June 8, 2020: cobalt-60, cesium-134, cesium-137, and ruthenium-103. In addition, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)[4] has reported that a station of its monitoring network located in Sweden had detected this elevation.

[1] https://www.dsa.no/nyheter/95196/svaert-lave-nivaa-av-radioaktivt-jod-maalt-i-finnmark-og-paa-svalbard

[2] https://www.stralsakerhetsmyndigheten.se/press/nyheter/2020/mycket-laga-nivaer-av-radioaktiva-amnen-uppmatta-i-sverige/

[3] https://www.stuk.fi/-/helsingin-ilmassa-pienia-maaria-keinotekoisia-radioaktiivisia-aineita-viime-viikolla

[4] https://twitter.com/SinaZerbo/status/1276559857731153921

Regarding the origin of the release, the RIVM[5], the Dutch institute responsible for monitoring environmental radioactivity, has indicated that these radionuclides could have originated from damage to fuel elements of nuclear power plants. The RIVM clarified that these radionuclides could have been transported on a trajectory going from Western Russia to the Nordic countries. In his communication, the CTBTO Secretary also published a map on the possible origin of the plume during the 3 days prior to the detections. The area concerned covers Western Russia, the South of the Nordic countries and part of the Baltic countries.

The IAEA[6] has since confirmed that the source of the release was probably linked to a reactor in operation or undergoing maintenance. The IAEA said it considered it unlikely that the release of these radionuclides would originate from nuclear fuel processing operations or from the use of radiation sources in the nuclear industry or in the medical sector. To date, no country in the region affected by the releases has declared to be aware of an incident that occurred at a facility or of any operation that could have produced it.

IRSN shares IAEA's analysis. IRSN indeed notes a significant activity of cobalt-60. This element is an "activation product" which is formed when corrosion products from the steel of a primary circuit are subjected to a neutron flux in the core of a nuclear reactor. Non-volatile, it can migrate in the primary circuit water.

In addition to cobalt-60, the other radionuclides measured (cesium-134, cesium-137, ruthenium-103, ruthenium-106, cerium-141, zirconium-95, and niobium-95) and their relative proportions correspond to an irradiated nuclear fuel whose irradiation would have ended several months ago, as indicated in the IRSN information report of June 30, 2020.

IRSN also highlights the absence of other radioactive products (such as iodine-131 and strontium-90) in the releases that are usually observed in a scenario directly involving nuclear fuel.

# 2. MEASURES IN FRANCE AND ABROAD

**Measurements in France**

An update of the measurements made in the North of France (part of the territory which could potentially be reached by air masses coming from Northern Europe) by the stations of the IRSN’s OPERA[7] network is presented below.

[5] RIVM : National Institute for Public Health and the Environment – Pays-Bas https://www.rivm.nl/nieuws/radioactieve-stoffen-gedetecteerd-in-lucht-boven-noord-europa

[6] https://www.iaea.org/newscenter/pressreleases/low-levels-of-radioisotopes-detected-in-europe-likely-linked-to-a-nuclear-reactor-iaea

[7] See appendix presenting the IRSN OPERA network.

***Table 1: IRSN measurements of the airborne cesium-137, cesium-134, cobalt-60, ruthenium-103 and ruthenium-106 air activity***

| Sampling location (department) | Collection period from | to | Activity in $^{137}Cs$ in air (in µBq/m$^3$) | Activity in $^{134}Cs$ in air (in µBq/m$^3$) | Activity in $^{60}Co$ in air (in µBq/m$^3$) | Activity in $^{103}Ru$ in air (in µBq/m$^3$) | Activity in $^{106}Ru$ in air (in µBq/m$^3$) |
|---|---|---|---|---|---|---|---|
| * Bure (55) | 08/06/2020 | 15/06/2020 | 0,020 ± 0,012 | < 0,016 | < 0,014 | < 0,015 | < 0,159 |
| * Bure (55) | 15/06/2020 | 22/06/2020 | 0,022 ± 0,011 | < 0,018 | < 0,020 | < 0,017 | < 0,170 |
| * Bure (55) | 22/06/2020 | 29/06/2020 | 0,054 ± 0,018 | < 0,022 | < 0,036 | < 0,021 | < 0,218 |
| * Dijon (21) | 10/06/2020 | 18/06/2020 | 0,025 ± 0,018 | < 0,024 | < 0, 030 | < 0,021 | < 0,246 |
| * Dijon (21) | 18/06/2020 | 26/06/2020 | 0,041 ± 0,020 | < 0,024 | < 0, 027 | < 0,024 | < 0,220 |
| * Orsay (91) | 10/06/2020 | 17/06/2020 | 0,034 ± 0,020 | < 0,024 | < 0,030 | < 0,028 | < 0,294 |
| * Orsay (91) | 17/06/2020 | 24/06/2020 | 0,034 ± 0,020 | < 0,027 | < 0,03 | < 0,0238 | < 0,235 |
| * Orsay (91) | 24/06/2020 | 01/07/2020 | 0,040 ± 0,020 | < 0,023 | < 0,020 | < 0,023 | < 0,212 |
| * Revin (08) | 09/06/2020 | 16/06/2020 | 0,044 ± 0,026 | < 0,028 | < 0,027 | < 0,027 | < 0,305 |
| * Revin (08) | 16/06/2020 | 23/06/2020 | < 0,022 | < 0,018 | < 0,018 | < 0,018 | < 0,169 |
| * Revin (08) | 23/06/2020 | 30/06/2020 | 0,030 ± 0,019 | < 0,025 | < 0,021 | < 0,023 | < 0,245 |
| ** Brest (29) | 13/06/2020 | 22/06/2020 | < 0,6 | < 0,6 | < 0,8 | < 0,6 | < 5 |
| ** Brennilis (29) | 16/06/2020 | 23/06/2020 | < 0,6 | < 0,6 | < 0,7 | < 0,6 | < 4,9 |
| ** Omonville (50) | 08/06/2020 | 15/06/2020 | < 0,47 | < 0,46 | < 0,6 | < 0,5 | < 4,6 |
| ** Omonville (50) | 15/06/2020 | 22/06/2020 | < 0,6 | < 0,6 | < 0,7 | < 0,7 | < 5 |
| ** Paluel (76) | 15/06/2020 | 22/06/2020 | < 0,6 | < 0,6 | < 0,6 | < 0,6 | < 4 |
| ** Penly (76) | 15/06/2020 | 22/06/2020 | < 0,5 | < 0,45 | < 0,7 | < 0,6 | < 4,3 |
| ** Gravelines (59) | 15/06/2020 | 22/06/2020 | < 0,6 | < 0,6 | < 0,8 | < 0,6 | < 5 |
| ** Maubeuge (59) | 22/06/2020 | 29/06/2020 | < 1,0 | < 1,1 | < 1,2 | < 1,1 | < 9 |
| ** Villeneuve d'Ascq (59) | 23/06/2020 | 26/06/2020 | < 2,1 | < 1,9 | < 2,5 | < 2 | < 17 |
| ** Cattenom (57) | 22/06/2020 | 29/06/2020 | < 0,6 | < 0,6 | < 0,8 | < 0,6 | < 5 |
| ** Chooz (08) | 22/06/2020 | 29/06/2020 | < 0,6 | < 0,6 | < 0,7 | < 0,6 | < 5 |
| ** Nancy (54) | 22/06/2020 | 29/06/2020 | < 0,7 | < 0,6 | < 0,7 | < 0,6 | < 6 |
| ** Fessenheim (68) | 22/06/2020 | 29/06/2020 | < 0,6 | < 0,5 | < 0,6 | < 0,6 | < 4,7 |

*Results indicated after the < symbol correspond to values below the decision threshold.*
*Activities are returned on the date of mid-collection (by agreement).*
*Localities whose names are preceded by an * are equipped with a station with very high sampling rate (400 to 700 m$^3$/h).*
*Localities whose names are preceded by an ** are equipped with a station a sampling rate of 80 m$^3$/h.*

**These results do not highlight the presence of radionuclides[8] detected in Northern Europe. This indicates that the contamination levels of the most marked air masses, which reached France on June 25 and 26, 2020 (cf. Figures 1 to 5), are nevertheless too low to be detected even with high-efficiency counting devices like those operated by IRSN.**

The absence of detection, in the air masses that entered France, of the released radionuclides is consistent with IRSN's numerical simulations[9] (see Figures 1 to 5). These estimate that the levels of radioactivity in these air masses are, for all the radionuclides identified, of the order of or less than 0.01 µBq/m$^3$.

[8] Cesium-137 measured at trace levels (<0.1 µBq/m$^3$) comes from the persistence of the fallout from the Chernobyl accident and from atmospheric nuclear tests.

[9] It was assumed, on the basis of available measurements and place of the more plausible origin (see §3), that the release occurred between 13 and 23 June 2020.

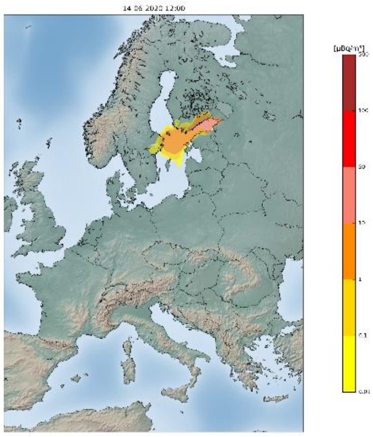

Figure 1: Map of the transport of air masses in Europe on 06/14/2020.

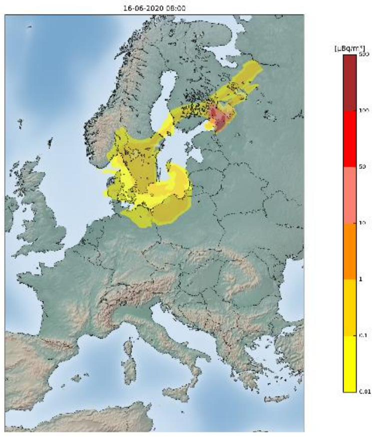

Figure 2: Map of the transport of air masses in Europe on 06/16/2020.

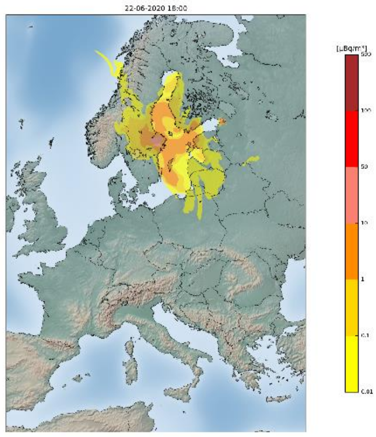

Figure 3: Map of the transport of air masses in Europe on 06/22/2020.

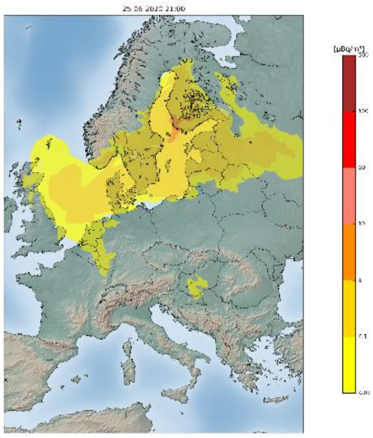

Figure 4: Map of the transport of air masses in Europe on 06/25/2020.

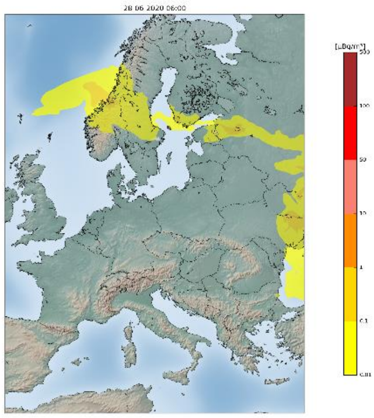

Figure 5: Map of the transport of air masses in Europe on 06/28/2020.

## Measurements abroad

Since the publication of IRSN information report of June 30, 2020, new measurements have been published by Sweden and Finland (Cf. Appendix 2).

During the period from June 15, 2020 to June 22, 2020, other radionuclides were detected (zirconium-95, niobium-95, ruthenium-106 and cerium-141) at very low levels of the order of or lower than 1 µBq/m$^3$. This reinforces the hypothesis of a release whose origin is linked to spent nuclear fuel.

# 3. POSSIBLE ORIGIN OF THIS ELEVATION AND MODELING

Based on the weather conditions provided by Météo France and the measurement results available in European countries, IRSN carried out simulations in order to locate the release area and assess the quantity of radionuclides released.

**Figure 6 below summarizes the results of these simulations. The most plausible release area is located on a territory covering part of the Baltic countries and Western Russia. However, it is not possible to specify the exact location of the release point given the limited number of available measurements and because of model uncertainties.**

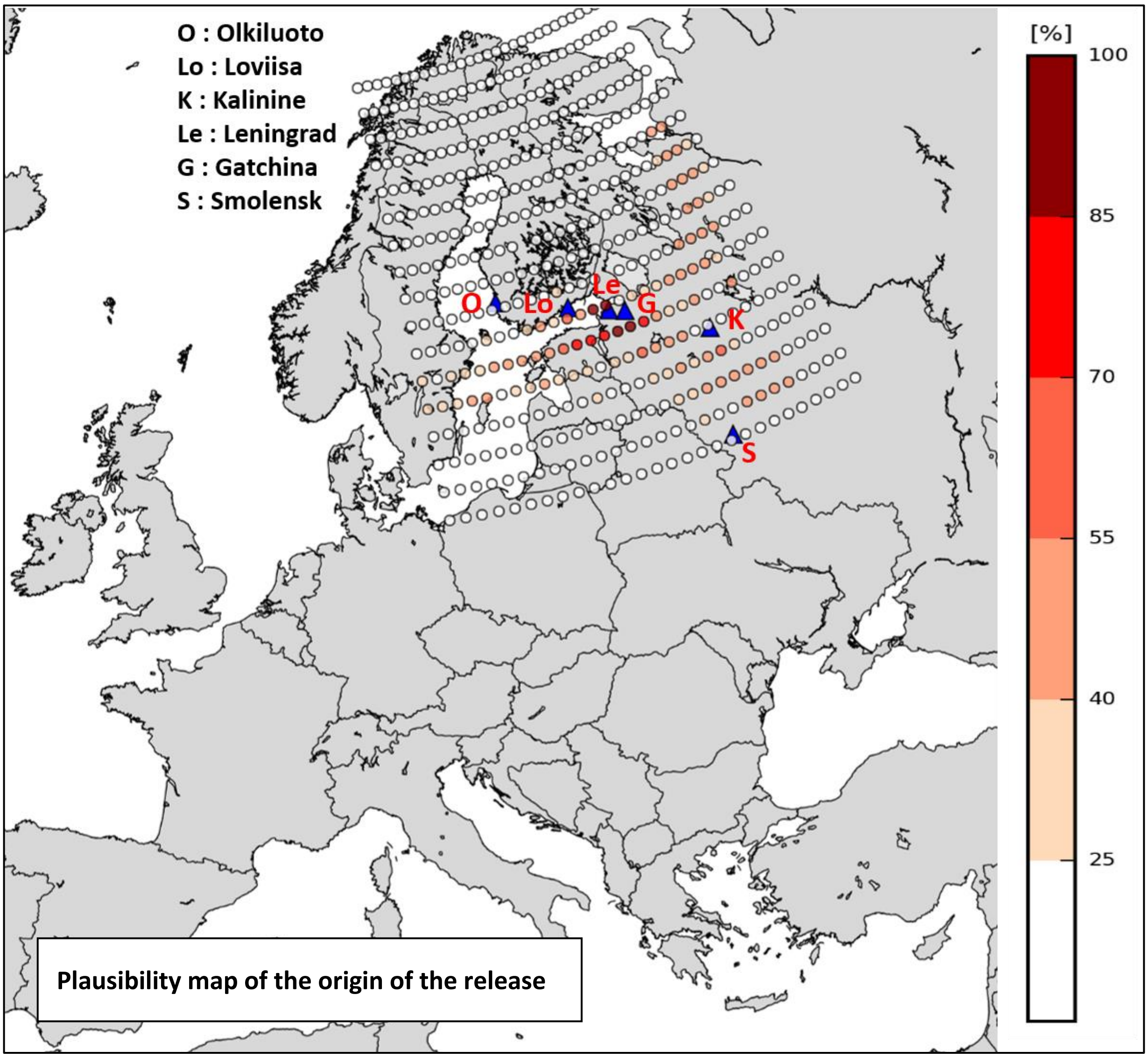


Figure 6: map showing the plausibility of the origin of the release and location of civilian nuclear facilities

*Map identifying, on the basis of the model-measurement comparison, the most plausible release area. For a simulated release at each point of the grid, the method consists in evaluating the percentage of modeled data which are in a factor of 5 compared to the measurements. For example, a release point with a color corresponding to the 85% color code means that 85% of the simulated measurements have values with a deviation of less than a factor of 5 from the values of the actual measurements. The area with the highest percentage is identified as the most plausible release area.*

**It should be remembered that the locations identified as the most plausible does not mean that the release necessarily took place at this point.**

**For the most plausible release area, the total released activity estimated by IRSN simulations is a few tens of gigabecquerels (GBq). Based on the measurements available, IRSN has modeled a release starting from June 13, 2020 and lasting until June 23, 2020**. The measurements available after this period do not allow to determine when the release ended due to the reversal of air mass trajectories. Indeed, the measurement stations which have detected the releases are no longer affected by the air masses possibly contaminated after this date.

By way of comparison, it should be noted that the level of activity released, estimated at a few tens of GBq, is higher than the activity levels of the annual gaseous discharges of cesium (cesium-134 + cesium-137) for the different nuclear power plants in the European Union which were, in 2018, in the order of 0.001 to 0.01 GBq[10].

# 4. RADIOLOGICAL CONSEQUENCES

Taking into account a release of a few tens of GBq for each of the radionuclides measured, IRSN estimated that the effective dose received by a person located 500 meters from the release point, was of the order of a few tens of microsievert (exposure linked to inhalation and to external exposure over the estimated duration of the release). Over a period of one year, for this same person, the effective dose which would result from external exposure following the deposition of radionuclides and the ingestion of foodstuffs contaminated by these deposition, would be of the order of a few hundred microsieverts.

**This dosimetric assessment shows that the exposures resulting from the levels of radioactivity in the air measured in Northern European countries concerned by the releases, are low in the immediate vicinity of the release point, and insignificant at longer distance (especially in the countries where it has been measured).**

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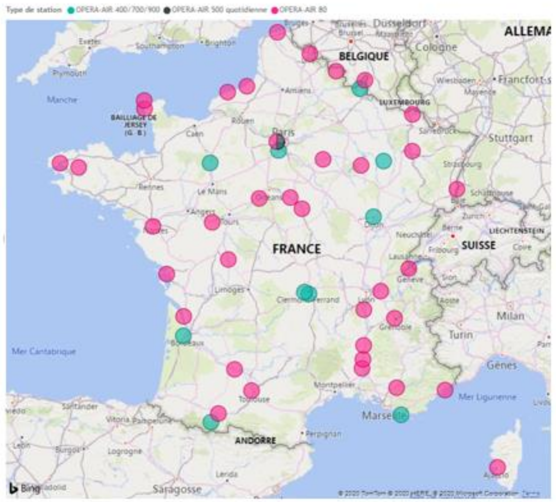
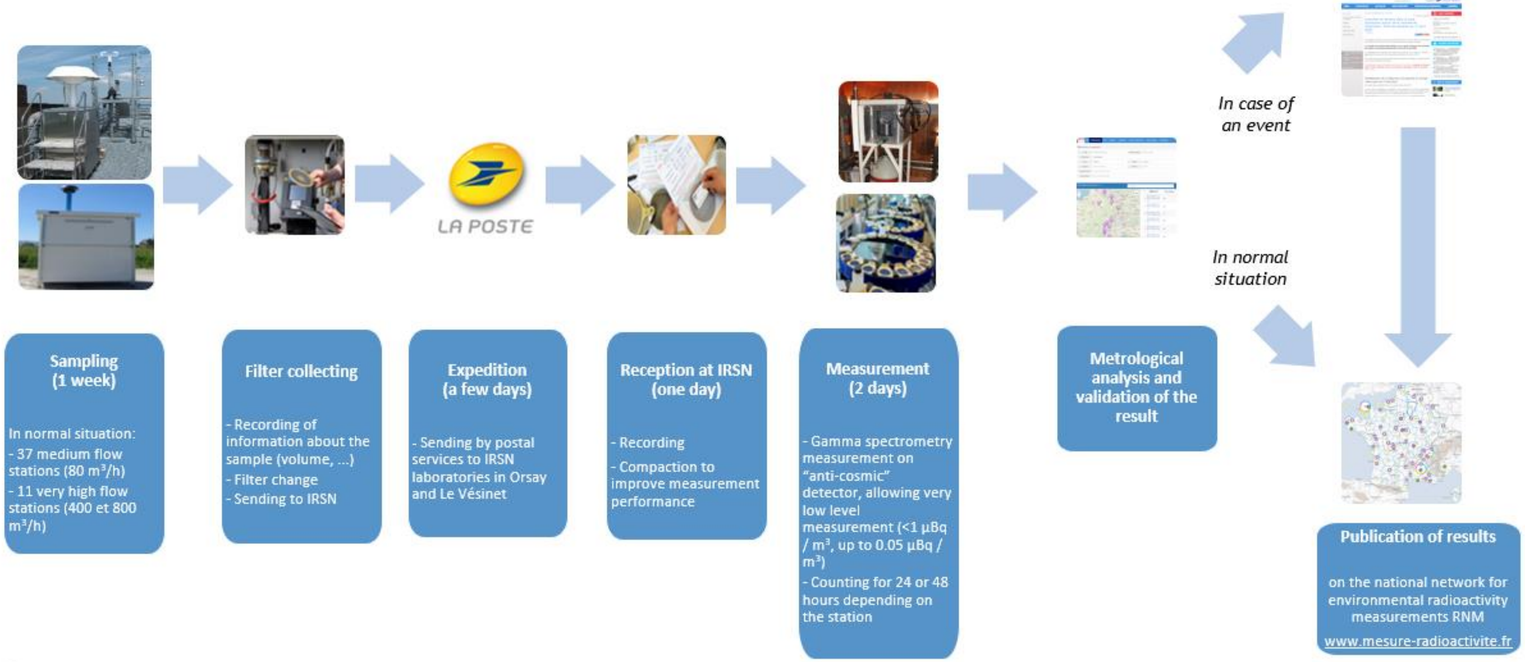
[10] https://europa.eu/radd/index.dox

# APPENDIX 1: THE IRSN OPERA NETWORK

**Map of the IRSN OPERA-AIR network**

Monitoring radioactivity in air by measuring aerosols taken from filters.
37 medium flow stations (80 m³ / h)
11 very high flow stations (400 to 800 m³ / h)
spread over the whole territory



# APPENDIX 2: RESULT OF MEASUREMENTS ABROAD

| Country | City | Start of sampling | End of sampling | Radionuclide | Volume activity in air ($\mu Bq/m^3$) |
|---|---|---|---|---|---|
| Sweden | Visby | 08/06/2020 | 15/06/2020 | Cs-134 | 0,8 |
| Sweden | Visby | 08/06/2020 | 15/06/2020 | Cs-137 | 1,3 |
| Sweden | Visby | 08/06/2020 | 15/06/2020 | Co-60 | 0,2 |
| Sweden | Visby | 08/06/2020 | 15/06/2020 | Ru-103 | 0,1 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Cs-134 | 0,6 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Cs-137 | 0,7 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Co-60 | 0,4 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Ru-103 | 0,7 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Ru-106 | 1,4 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Nb-95 | 1,0 |
| Sweden | Visby | 15/06/2020 | 22/06/2020 | Zr-95 | 0,7 |
| Sweden | Stockholm | 22/06/2020 | 23/06/2020 | Cs-137 | 9,6 |
| Sweden | Stockholm | 22/06/2020 | 23/06/2020 | Cs-134 | 9,7 |
| Sweden | Stockholm | 22/06/2020 | 23/06/2020 | Ru-103 | 4,3 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Co-60 | 6,1 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Zr-95 | 2,1 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Nb-95 | 3,7 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Ru-103 | 1,9 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Cs-134 | 15,0 |
| Finland | Helsinki | 16/06/2020 | 17/06/2020 | Cs-137 | 11,0 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Co-60 | 0,7 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Zr-95 | 0,2 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Nb-95 | 0,4 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Ce-141 | 0,2 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Ru-103 | 0,3 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Cs-134 | 1,7 |
| Finland | Kotka | 15/06/2020 | 22/06/2020 | Cs-137 | 2,4 |

Data sources:
- Finland: https://www.stuk.fi/web/en/topics/environmental-radiation/radioactivity-in-outdoor-air
- Sweden: https://www.stralsakerhetsmyndigheten.se/press/nyheter/2020/stralsakerhetsmyndigheten-rapporterar-svenska-matvarden-till-iaea/