INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

30 November, 2011

INFORMATION NOTICE

No health risk related to airborne traces of iodine-131 from Hungary

In its information notice on November 15, IRSN reported that it had detected traces of iodine-131 in the form of airborne particles. The traces were detected in a number of samples taken by aerosol monitoring stations in the IRSN OPERA-Air network. The results of sampling measurements taken over the first ten days of November were around a few microbecquerels per cubic meter of air ($\mu Bq/m^3$). These values are close to the detection limits of the most effective measuring methods. Although iodine-131 is not normally found in the air throughout the country, its presence did not give any cause for concern for the population's health or the environment.

It was detected in France following similar detection reports in various countries in central and northern Europe. As the reasons for this radioactive pollution were unknown, IRSN performed trajectory calculations to try to locate the origin of the air masses transporting the iodine-131. Meanwhile, the International Atomic Energy Agency (IAEA) issued a press release[1] on November 17, indicating that it had received information from the Hungarian Atomic Energy Authority (HAEA) that: "*…the source of the iodine-131 detected in Europe was most probably a release to the atmosphere from the Institute of Isotopes Ltd., Budapest.*" The institute produces radioisotopes for healthcare, industrial, and research applications. According to the HAEA, the release is thought to have begun on September 8, 2011, with a period of increased intensity on October 12-14. The authority stated, however, that the quantity of iodine-131 released over the period was below the institute's authorized annual radioactive release limit. The cause of the release has yet to be determined and is still under investigation.

This information notice provides an update of measurement results in France, together with IRSN's trajectory analysis of the air masses that explain the iodine-131 traces observed in Europe. Based on currently available technical data, IRSN also estimated the radiological impact of this radioactive release in the near field, in other words in the Budapest region.

1. Update on airborne iodine-131 measurements in France

The measurement results obtained by IRSN's specific monitoring structure set up in France are given in the table in the appendix. They mostly concern aerosol sampling carried out at high filtration rate or very high filtration rate stations designed to achieve very low detection limits. IRSN's latest results confirm the initial observations published in the notice issued on November 15 (see map in Figure 1).

[1] http://www.iaea.org/newscenter/pressreleases/2011/prn201127.html

I-131 in particulate form (µBq/m3)

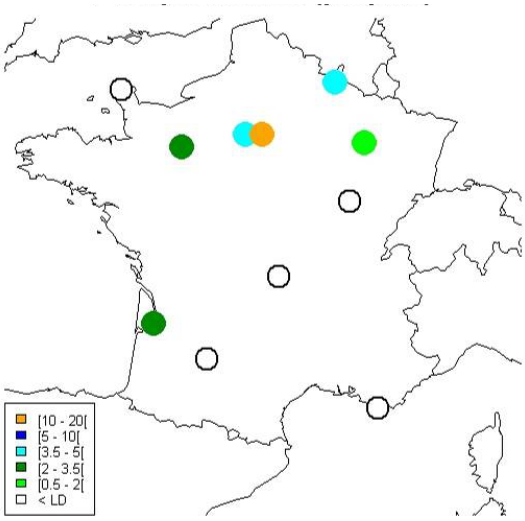


Figure 1 – Map showing maximum iodine-131 particulate concentration levels measured in the air at the high filtration rate or very high filtration rate stations of the IRSN OPERA-air monitoring network between September 28 and November 15, 2011

Significant values (i.e. those above measuring instrument detection levels) were generally measured on samples taken between November 2 (the earliest) and November 10, for the most part at stations located west of a Biarritz-Strasbourg line. Nonetheless, the iodine-131 levels measured were minute (a few µBq/m^3) and very close to the detection limits of the measuring instruments used. For the sake of comparison, the highest values reported by the IAEA for central and northern Europe were: 65 µBq/m^3 in eastern Austria, 27 µBq/m^3 in the Czech Republic, 16 µBq/m^3 in Slovakia, 14 µBq/m^3 in the east of Germany, 13 µBq/m^3 in Poland, 7 µBq/m^3 in Ukraine, and 5 µBq/m^3 in Sweden.

The results of IRSN samples taken after November 10 were all below the detection limits, indicating that the radioactive pollution in France lasted only a few days during the first ten days of November.

Gaseous iodine-131 samples were also taken in Le Vésinet near Paris. In order to guarantee effective sampling, only stations with a low filtration rate can be used to take gaseous iodine samples on activated carbon filters, which is not the case for iodine particulates. For this reason, detection limits were higher than for the iodine particulate fraction. All the gaseous iodine-131 concentration values obtained by IRSN were below the detection limit, between 250 and 280 µBq/m^3 of air (Table 1).

Table 1 - Gaseous iodine-131 concentration measurement results, obtained from samples taken in Le Vésinet between November 9 and 14

Sampling site	**Sampling period**		**Gaseous iodine-131 activity concentration in the air (in µBq/m^3) in the middle of the sampling period**
LE VESINET (78)	09/11/2011	10/11/2011	< 280
LE VESINET (78)	10/11/2011	12/11/2011	< 250
LE VESINET (78)	12/11/2011	14/11/2011	< 250

For information, gaseous iodine-131 was detected in Austria[2] and the Czech Republic in early November, showing that this radioisotope could be 5 to 20 times more abundant in the gaseous form

[2] http://www.lebensministerium.at/suchergebnisse.html?queryString=I-131

than in the particulate form. Thus, even assuming that the particulate-to-gas ratio for iodine-131 had also been 1:20 in France, the concentration of gaseous iodine-131 would still have been below the detection limits of the measuring methods used, as was the case.

All these results confirm that the traces of airborne iodine-131 detected in France are very small and present no health risk. For the sake of comparison, iodine-131 concentrations in the air measured in early November were 100 times lower than those observed in France in the first weeks following the Fukushima accident. Although these concentrations can be measured in the air, they are too low to have had any detectable environmental impact in terms of deposition in the soil.

2. Trajectory analysis of air masses explaining the traces of airborne iodine-131 detected in Europe

Following reports that traces of airborne iodine-131 had been detected in several European countries, including France, IRSN proceeded to reconstruct the trajectories of air masses that could have explained the pollution. This involved testing several assumptions of radioactive release in central Europe.

The IAEA press release of November 17, indicating that Hungary was the probable source of the radioactive release, allowed IRSN to focus its analysis on the Institute of Isotopes Ltd. in Budapest. It therefore conducted a trajectory analysis of air masses coming from Hungary on various days in early November. Results showed that air masses leaving Budapest on November 3, 4, and 5 reached France as of November 7, after passing over the Czech Republic, Poland, Germany, and Denmark (see maps in Figure 2).

The iodine-131 detection sites and dates given by other European countries located along the path of these air masses were consistent with IRSN's trajectory analyses.

According to these calculations, France was affected more by release emitted on November 6 and the following days.

The findings of these air mass trajectory analyses thus seem to support the hypothesis that the traces of iodine-131 detected in France and in other parts of Europe originated in Hungary.

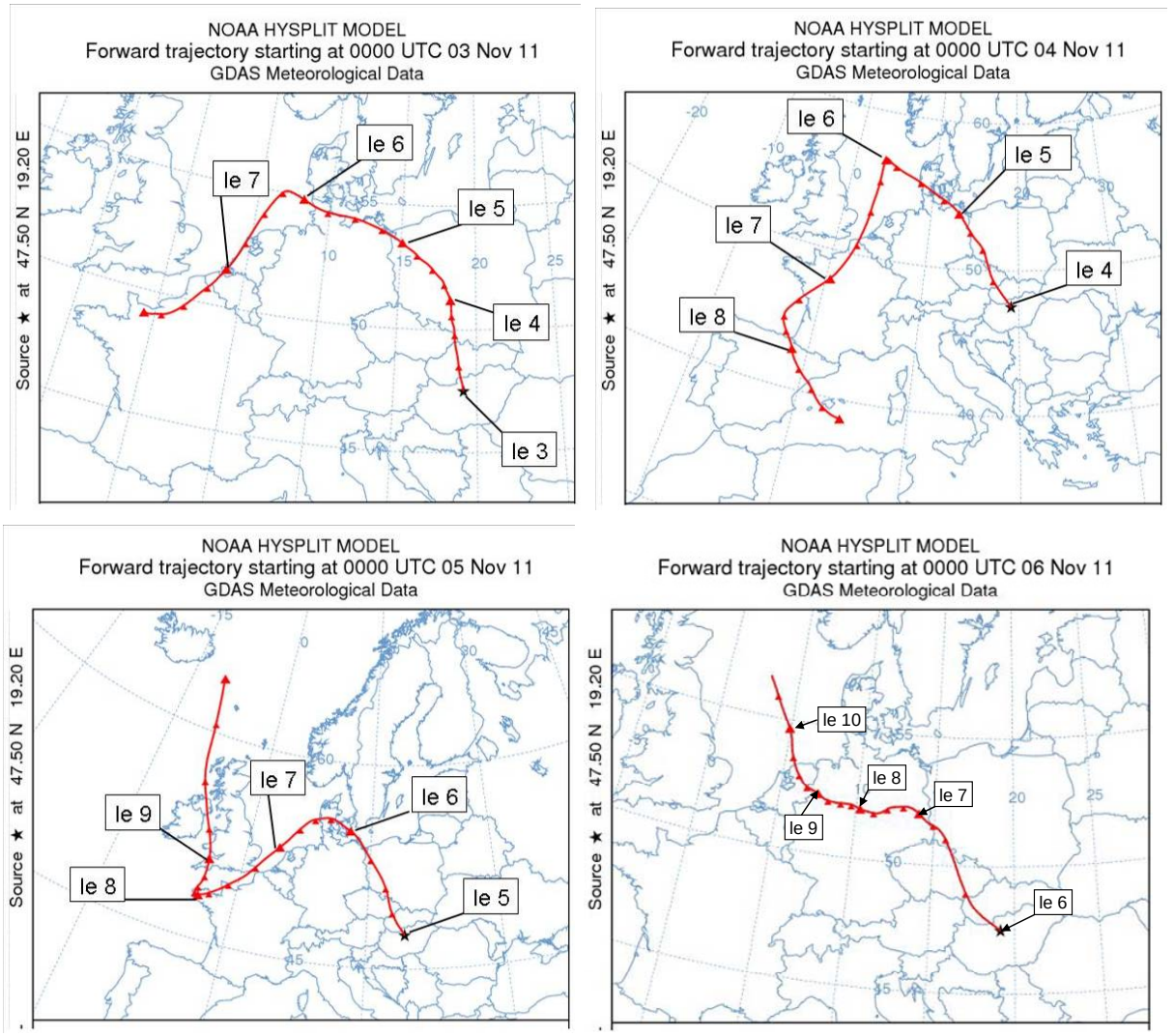


Figure 2 – Air mass trajectories from Budapest on November 3, 4, 5 and 6, 2011 (The red triangles along the trajectory line show the position of the air mass at 6-hour intervals). Note: the air masses concerned by these trajectories were spread over varying distances on either side of the trajectory lines.

3. Estimated radiological impact around Budapest

According to information published by the IAEA, the iodine-131 was released by the Isotope Institute in Budapest. The Hungarian authorities stated that the total activity of iodine-131 released to the atmosphere amounted to 342 GBq (gigabecquerel = billion Becquerel) between September 8 and November 16, 2011, of which 108 GBq was released in 48 hours between October 12 and 14. The isotope is thought to have been released through the facility's 80 m high stack.

Based on this information and weather data provided by Météo-France, the French meteorological service, IRSN used its *pX* atmospheric dispersion model to estimate the radiological impact of the incident within a 20 km radius of the Isotope Institute. The estimation was based on the assumption that, except during the intense release period of October 12-14, radioactive release occurred continuously and at a constant flow rate from September 8 to November 16. In the absence of specific information on the chemical forms of the released iodine, IRSN considered that the release

consisted entirely of gaseous iodine-131[3], which is the most conservative scenario in terms of inhaled dose. IRSN also took into consideration release height (80 m), which favors dispersion and reduces local impact.

The maps in Figure 3 show the spatial distribution of the maximum doses likely to have been absorbed by an unprotected one-year-old child due to exposure to the plume throughout the estimated release period ('unprotected' means that the child was constantly outdoors over the period). Based on the assumptions used for dose calculations, the maximum doses due to exposure to the iodine-131 plume would have been absorbed 2 km south-east of the site:

- 1.5 µSv effective dose (whole-body exposure indicator). For the record, the annual dose limit for persons exposed to radioactivity from nuclear activities under normal operating conditions is 1000 µSv in Europe;
- 28 µSv equivalent dose to the thyroid (specific dose to the thyroid gland, an organ that selectively takes up iodine-131). For the sake of comparison, a dose of 50,000 µSv is the value adopted in France to justify the administration of stable iodine pills in the event of accidental inhalation of radioactive iodine.

The radiological impact of the iodine-131 release falls as the distance from the site increases. On November 18, the Frédéric Joliot-Curie National Research Institute for Radiobiology of Hungary, which has an atmospheric radioactivity monitoring station in Budapest located about 9 km from the Isotope Institute, published the results of measurements that it had taken[4] : while particulate iodine-131 concentrations in this area are generally around 10 µBq/m^3, the measured values reported reached several tens of µBq/m^3 in September and October 2011, with a peak measurement of 173 µBq/m^3 at the end of September.

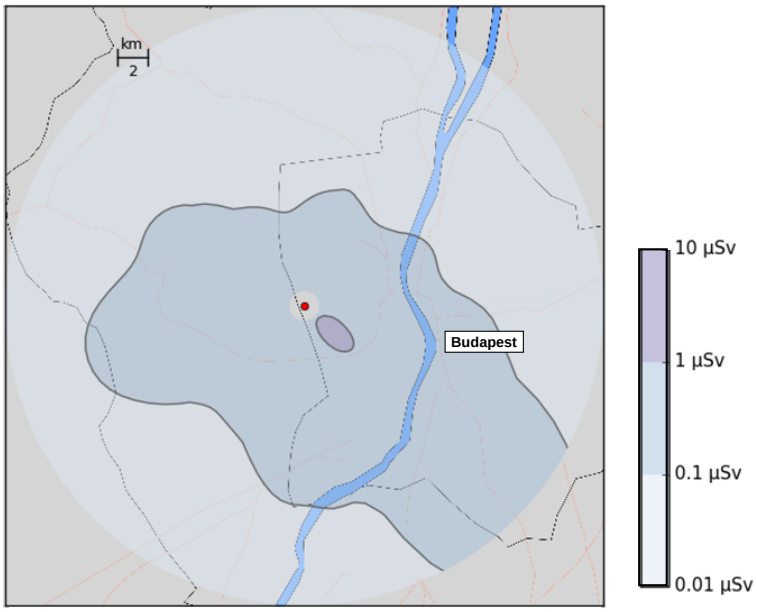
Iodine-131 concentration levels in the air were too low to lead to detectable internal contamination in persons in Budapest who might have been exposed to release. IRSN performed whole-body radiation dosimetry[5] on two French tourists who were in Budapest on November 8-12, but no traces of contamination were detected.

The above mentioned values of IRSN's highest potential doses are extremely low and have no impact on health. For the sake of comparison, the average effective dose due to exposure to natural radioactivity in France is 2400 µSv per year, while the thyroid dose due to potassium-40, a naturally-occurring radionuclide found in the human body, is about 300 µSv per year.

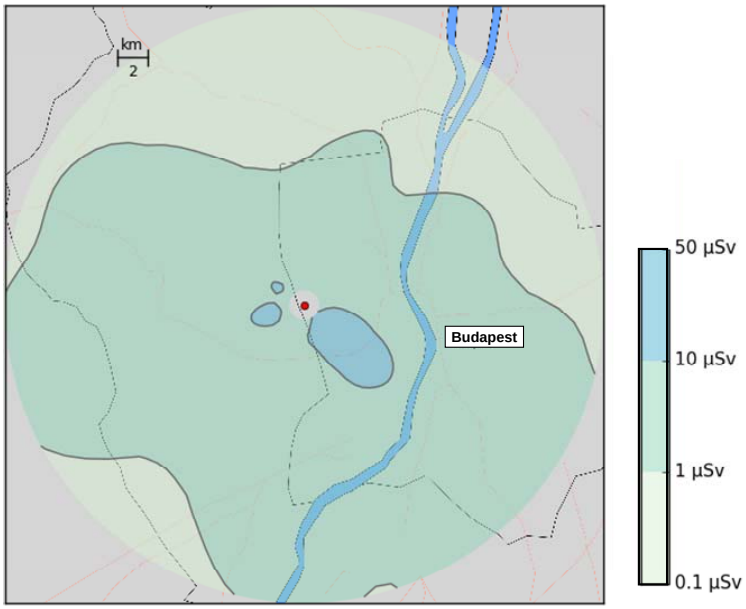
[3] The Hungarian Atomic Energy Authority issued a total activity source term without specifying the proportion of gaseous iodine-131. IRSN can neither verify this source term nor state whether it includes both physical forms of iodine.

[4] http://www.osski.hu/info/radiojod/radiojod_en.html

[5] Whole-body radiation dosimetry consists in directly measuring the activity of X- or gamma-ray emitting radionuclides in an individual's body. This is done using carefully calibrated radiation detectors placed as near as possible to the body.



Effective dose (in microsievert) likely to have been absorbed by an unprotected one-year-old child throughout the period of release



Equivalent dose to the thyroid (in microsievert) likely to have been absorbed by a one-year-old child throughout the period of release

Figure 3 – Spatial distribution of effective doses and equivalent doses to the thyroid due to exposure to the iodine-131 plume, liable to have been absorbed within a 20 km radius of the Isotope Institute in Budapest between September 18 and November 16 (IRSN estimation based on the pX model).

IRSN also modeled expected iodine-131 deposition on soil surfaces between September 8 and November 16 due to atmospheric dispersion of the release. The maximum area of deposition is located 2 km south-east of the point of release. The graph in Figure 4 shows possible time-related changes in iodine-131 surface activity in this area.

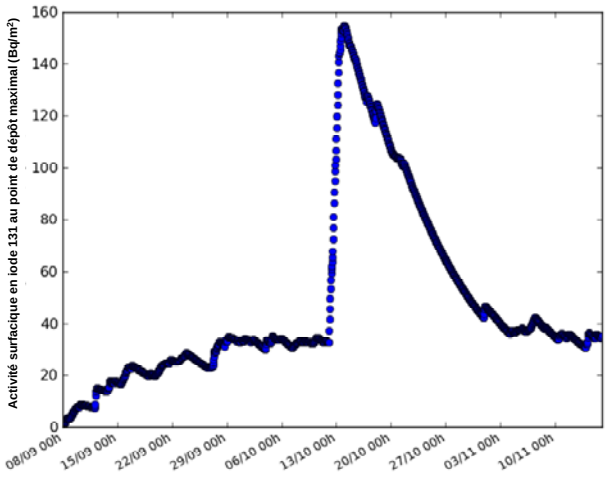


Figure 4 – Time-related changes in iodine-131 surface activity on the soil in the maximum fallout area

According to this model, iodine-131 deposition increased gradually as of September 8, reaching a surface activity plateau between 30 and 40 Bq/m^2 (equilibrium between freshly deposited activity each day and radioactive decay of the iodine-131 deposited earlier). Based on the model, maximum iodine-131 deposition at this point was reached on October 15, immediately after the most intense release period on October 12-14 reported by the Hungarian authorities. At this point in time, surface activity could have been around 150 Bq/m^2. The map in Figure 5 shows the spatial distribution of iodine-131 surface activity estimated by IRSN on the same date (October 15). Given the short radioactive half-life of iodine-131, this surface activity would have dropped rapidly over the next few days, as illustrated in Figure 4.

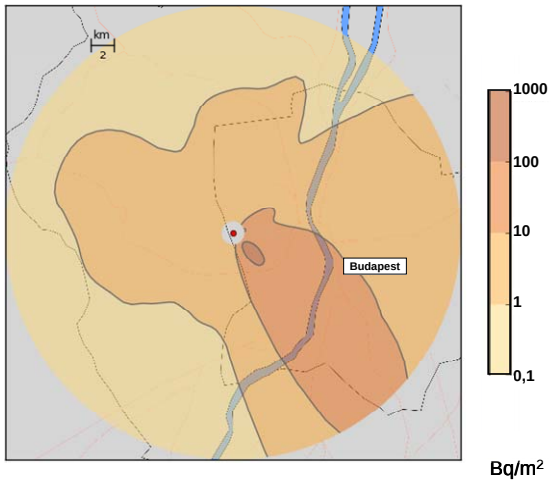


Figure 5 – Iodine-131 surface activity on the ground within a 20 km radius of the Isotope Institute in Budapest on October 15, 2011 (IRSN estimation using the pX model).

Estimated surface activities were low[6] and, based on the information on iodine-131 release provided by the Hungarian authorities, the radioactive deposits induced by this release are unlikely to have caused any contamination of foodstuffs beyond the maximum authorized levels[7] defined in European food regulations. The maximum theoretical values regarding contamination of leaf vegetables and

[6] For the sake of comparison, the iodine-131 deposits in the east of France in early May 1986, following the Chernobyl accident, may have reached several tens of thousands of Bq/m^2 and even exceeded 100,000 Bq/m^2 in some areas.

[7] 2000 Bq/kg iodine-131 for leaf vegetables and 300 Bq/L for milk, based on uptake values in Europe following the Fukushima accident.

cow's milk in the maximum fallout area were respectively 76 Bq/kg in fresh stuff and 22 Bq/L. In the case of a child aged between 2 and 7 years, consuming 70 g/day of leaf vegetables (lettuce, spinach, etc.) and 60 g/day of milk, of which 70 to 80% is produced locally, the equivalent intake dose to the thyroid over one month is estimated at 70 µSv. This theoretical estimation is probably extremely conservative and not very realistic given the time of year and the surroundings of the Hungarian nuclear site. From the aerial views of the Isotope Institute site in Budapest in Figure 6, it can be seen that the site is in a wooded area, apparently with no significant farming activities; within a 2 km radius of the site built-up areas can be observed, especially in the south-east (presumed to be the maximum fallout area).

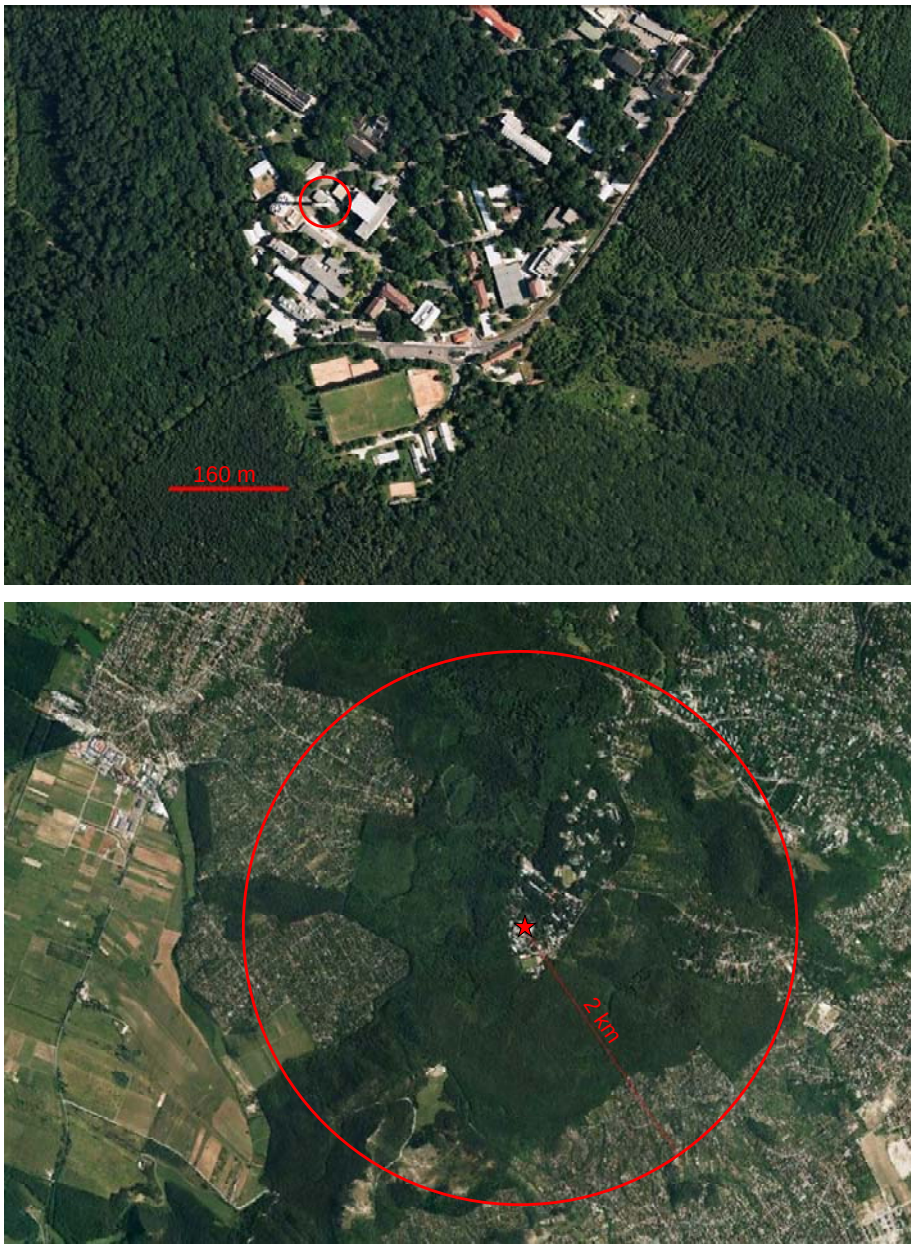


Figure 6 – Aerial view (Google Earth images) of the Isotope Institute in Budapest (top) and the surrounding area within a 2 km radius of the site (bottom). The Institute stack where the release originated is ringed in red in the top photo.

4. Conclusions

The traces of iodine-131 detected in France and in other countries in central and northern Europe can generally be explained by radioactive release from the Isotope Institute in Budapest, as reported by the IAEA in its press release on November 17, 2011.

Based on information concerning the release provided by the Hungarian authorities, radiological impact estimations in the vicinity of the site where the release occurred point to very low doses, even for "unprotected one-year-old children". The traces of iodine-131 detected in France and other European countries are too low to represent any health risk whatsoever.

In so far as the origin of the release has now been identified, and in view of the low potential radiological impact, IRSN considers that there is no need for protective or monitoring measures to be implemented for those staying or having stayed in Budapest. Furthermore, it considers that the situation does not call for any restrictions on the consumption of food produce from the city and that such restrictions were unnecessary even when release was its highest.

The circumstances, under which the release of iodine-131 occurred in Budapest starting in September 2011, have yet to be determined. According to the Hungarian authorities, the iodine-131 activity released between September 8 and November 16 represents around 20% of the annual release limit authorized for the Isotope Institute in Budapest. For the sake of comparison, the CIS BIO nuclear facility at the Saclay site near Paris, which also produces isotopes for medical purposes, has an authorized annual release limit of 0.6 GBq of radioactive iodine (i.e. nearly 3000 times less than that of the Isotope Institute in Budapest) and actually released 0.16 GBq in 2010. In addition, the accidental release of iodine-131 that occurred in Belgium in August 2008 at the National Institute for Radioelements in Fleurus, which also produces radioactive isotopes for medical use, was estimated at 47 GBq by AFCN, the Belgian Federal Agency for Nuclear Control, i.e. about seven times less than the release reported in Hungary. The Belgian incident, which also had a very limited radiological impact, was classed as an INES Level 3 event.

APPENDIX – Measurement results for airborne particulate iodine-131 in France

The following table shows all the values obtained to date by IRSN[8] on aerosol samples taken at stations in the OPERA-Air monitoring network at high or very high filtration rates. Some samples were invalidated as a result of technical problems (filter clogging, motor failure) affecting the operation of some sampling stations. This accounts for the sampling interruptions at some stations.

Sampling site	Sampling period		Particulate iodine-131 activity concentration in the air (in µBq/m^3) in the middle of the sampling period
	From	*To*	
ALENCON (61)	30/09/2011	10/10/2011	< 3.9
ALENCON (61)	10/10/2011	20/10/2011	< 1.1
ALENCON (61)	20/10/2011	31/10/2011	< 1.0
ALENCON (61)	31/10/2011	05/11/2011	< 0.9
ALENCON (61)	05/11/2011	10/11/2011	**3.8 +/- 1.5**
ALENCON (61)	10/11/2011	15/11/2011	< 0.7
ALENCON (61)	15/11/2011	20/11/2011	< 0.5
BORDEAUX-MERIGNAC (33)	30/09/2011	10/10/2011	< 3.5
BORDEAUX-MERIGNAC (33)	10/10/2011	20/10/2011	< 1.1
BORDEAUX-MERIGNAC (33)	20/10/2011	31/10/2011	< 0.43
BORDEAUX-MERIGNAC (33)	05/11/2011	10/11/2011	**2.22 +/- 0.29**
BORDEAUX-MERIGNAC (33)	10/11/2011	15/11/2011	< 0.7
BORDEAUX-MERIGNAC (33)	15/11/2011	20/11/2011	< 1.6
BURE (55)	30/09/2011	10/10/2011	< 2.9
BURE (55)	10/10/2011	20/10/2011	< 1.4
BURE (55)	21/10/2011	02/11/2011	< 0.5
BURE (55)	02/11/2011	07/11/2011	**0.79 +/- 0.22**
BURE (55)	07/11/2011	10/11/2011	**0.61 +/- 0.25**
BURE (55)	10/11/2011	15/11/2011	< 0.6
BURE (55)	15/11/2011	18/11/2011	< 2.4
CHARLEVILLE-MEZIERES (08)	30/09/2011	10/10/2011	< 2.9
CHARLEVILLE-MEZIERES (08)	10/10/2011	20/10/2011	< 0.8
CHARLEVILLE-MEZIERES (08)	20/10/2011	31/10/2011	< 0.8
CHARLEVILLE-MEZIERES (08)	31/10/2011	05/11/2011	< 1.0
CHARLEVILLE-MEZIERES (08)	05/11/2011	10/11/2011	**4.6+/- 0.5**
CHARLEVILLE-MEZIERES (08)	10/11/2011	15/11/2011	< 1.9
CHARLEVILLE-MEZIERES (08)	15/11/2011	20/11/2011	< 0.7

[8] The values in this table may differ slightly from those given in IRSN's information notice of November 15, 2011. This is due to new measurements taken on the same samples but over longer periods of time for the sake of greater precision and to obtain lower detection limits.

Sampling site	Sampling period		Particulate iodine-131 activity concentration in the air (in µBq/m^3) in the middle of the sampling period
CLERMONT-FERRAND (63)	05/10/2011	12/10/2011	< 6
CLERMONT-FERRAND (63)	12/10/2011	19/10/2011	< 4.5
CLERMONT-FERRAND (63)	26/10/2011	02/11/2011	< 0.5
CLERMONT-FERRAND (63)	02/11/2011	09/11/2011	< 0.7
CLERMONT-FERRAND (63)	09/11/2011	16/11/2011	< 0.7
DIJON (21)	30/09/2011	10/10/2011	< 2.0
DIJON (21)	10/10/2011	20/10/2011	< 0.9
DIJON (21)	20/10/2011	25/10/2011	< 2.0
GOLFECH (82)	24/10/2011	31/10/2011	< 0.7
GOLFECH (82)	31/10/2011	07/11/2011	< 0.7
GOLFECH (82)	07/11/2011	14/11/2011	< 0.7
LA SEYNE S/MER (83)	30/09/2011	11/10/2011	< 2.6
LA SEYNE S/MER (83)	11/10/2011	20/10/2011	< 1.5
LA SEYNE S/MER (83)	20/10/2011	02/11/2011	< 0.5
LA SEYNE S/MER (83)	02/11/2011	07/11/2011	< 2.8
LA SEYNE S/MER (83)	07/11/2011	10/11/2011	< 0.6
LA SEYNE S/MER (83)	10/11/2011	15/11/2011	< 0.6
LE VESINET (78)	01/11/2011	06/11/2011	< 4.9
LE VESINET (78)	06/11/2011	09/11/2011	**12 +/- 6**
LE VESINET (78)	09/11/2011	12/11/2011	< 5.4
OCTEVILLE (50)	9/11/2011	12/11/2011	< 8.0
OCTEVILLE (50)	12/11/2011	15/11/2011	< 6.0
OCTEVILLE (50)	15/11/2011	17/11/2011	< 4.0
OCTEVILLE (50)	17/11/2011	21/11/2011	< 4.0
ORSAY (91)	30/09/2011	10/10/2011	< 3.2
ORSAY (91)	20/10/2011	28/10/2011	< 0.8
ORSAY (91)	28/10/2011	04/11/2011	< 1.1
ORSAY (91)	04/11/2011	10/11/2011	**4.2+/- 0.4**
ORSAY (91)	10/11/2011	15/11/2011	< 0.34
ORSAY (91)	15/11/2011	21/11/2011	< 0.5
PUY DE DOME (63)	28/09/2011	05/10/2011	< 5.4
PUY DE DOME (63)	02/11/2011	09/11/2011	<0.9