
Measurement campaign at La Hague by European mobile laboratories: a technical and sociological experiment

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Abstract: The multi-disciplinary expert appraisal by the Nord-Cotentin Radioecology Group provided results that were published in 1999 and essentially related to:

- the inventory of the radioactive releases from local nuclear facilities,
- critical review of measurements made in the environment,
- models of transfer of radionuclides through the environment,
- estimation of doses and associated leukaemia risks.

In view of the unavoidable uncertainties of a retrospective study, the Group developed an evolving system for integrating new knowledge and results. The initiative of the local “Angry Mothers” to organise an international measurement campaign in the north of the Cotentin peninsula is perfectly consistent with this approach. The goal is to establish a radiological baseline corresponding to the existing situation by means of the following investigations, depending on the possibilities of the laboratories involved:

- *in-situ* gamma spectrometry measurements,
- environmental sample measurements,
- measurements in homes.

Apart from the scientific value of this initiative, interaction between measurement teams and local population is a key factor in motivating the “Angry Mothers” to involve themselves in the organisation of the exercise. The fact that residents of the Cherbourg area are volunteering to provide accommodation for the measurement teams represents a totally new development in this area and a significant example of solidarity, combined with a teaching aspect resulting from cooperation with schools in the region. This document reviews the information available on this technical and sociological experiment.

1. INTRODUCTION

The Nord-Cotentin Radioecology Group submitted its conclusions to the ministry for territorial development and the environment and to the secretary of state for health on 7 July 1999, after two years of work. On the basis of its findings, the number of cases of leukaemia that can be attributed to different sources of ionising radiation between 1978 and 1996, in individuals younger than 25, in the Beaumont-Hague district can be estimated as follows:

Source of radioactivity	Number of cases	
Nuclear facilities	0.0014	(routine releases 0.0009, accident releases 0.0005)
Radioactivity of natural origin	0.62	
Radioactivity of medical origin	0.20	
Other sources	0.01	(nuclear tests, Chernobyl accident)
Overall total (rounded off)	0.83	Over a period of 19 years

This best-estimate assessment of the levels of exposure to ionising radiation and the associated leukaemia risks for the population of the north of the Cotentin peninsula is based on probability calculations using measurements, hypotheses and models incorporating margins of uncertainty. The Group has been assigned a further mission of quantifying the margins of uncertainty and reducing the most penalising ones. These figures therefore do not have the same certainty as, for instance, the figure of 600 road deaths per year in Switzerland, which is based on verifiable records and accepted as true. This illustrates the difficulty of assessing a risk in the absence of an established cause and effect relationship. However, it is only possible to achieve zero death and zero releases by doing away with all vehicles and nuclear facilities respectively. The results obtained by the Group [1] actually indicate that the contribution of the local nuclear facilities to the radiological risk is slight, and does not appear to be reasonably of a nature to have a perceptible effect on health. The “Angry Mothers” initiative represents a desire to establish the truth in the context of the measurement process giving a snapshot of the local radiological situation. Although measurement is intrinsically objective, this is not the case for the interpretation of results, which depends on factors including prejudice and emotional and ideological sensitivity. Exchanges between the measurement teams and the population are intended to address these concerns. All those involved must be aware of their responsibilities when informing the public. After a brief review of the work of the Nord-Cotentin Radioecology Group, this document describes the particularities of the exercise and discusses the technological and sociological findings that have come to light. This corresponds to the open and evolving approach pruned by the Nord-Cotentin Radioecology Group.

2. THE NORD-COTENTIN RADIOECOLOGY GROUP

What makes the Group special is its composition (inspectors, French institutional experts, nuclear facility operators, members of associations and foreign experts) and that its brief is to make the broadest possible systematic critical analysis. The main findings of the Group in the four key areas of study are summarised below.

2.1 Inventory of radioactive releases from nuclear facilities

As regards the addition of radionuclides to the initial list, reconstitution of the releases of liquid and gaseous effluents from the different nuclear facilities located in the north of the Cotentin peninsula resulted in:

- the addition of 17 radionuclides produced by fission to the initial list of 25,
- the addition of 14 actinides to the initial list of 7,
- the addition of 8 radionuclides produced by activation to the initial list of 4.

Thus, overall, of the 75 radionuclides included in the validated and reconstituted release tables, 39 were added, representing 52%. Apart from routine releases, the incident and accident situations which resulted in off-site releases have been listed and detailed.

2.2 Critical review of measurements in the environment

The critical review of all the measurements in the environment took the form of the creation of a database containing validated information. This inventory of the samples and types of radioactivity measurements necessitated selection criteria focusing on the quality of the measurements and the computerised data. For this reason, only results obtained since 1978 were taken into account. This corpus of data and comments is extremely useful when the public demands answers concerning the distribution and variation in level of artificial reactivity in the north of the Cotentin peninsula. Despite a

lack of uniformity due to the different purposes of the measurements, the results are essentially consistent.

2.3 Models of transfer of radionuclides through the environment.

Comparison of the results obtained with existing models and field data shows that there is no perfect model, but that corrective factors can ensure that the local reality is properly reflected. In certain cases, such as near-field dispersion and modelling of the effect of spray, targeted sampling campaigns and special measurements nevertheless appear to be unavoidable. Such actions, some of which are currently in progress, constitute part of the strategy of reducing uncertainty.

2.4 Estimation of doses and the associated leukaemia risk

Two approaches have been studied:

- A “cohort” approach, involving demographic reconstruction, modelling of doses (individual and collective) to the bone marrow, selection of lifestyle parameters, the risk estimation model, allowance for all the different sources of exposure and cohort scenarios liable to be more conservative than average,
- A “special scenario” approach, involving modelling of the effective doses, and postulating scenarios and associated lifestyle parameters, as well as estimating individual effective doses for scenarios liable to be more conservative than average.

The table in the introduction summarises the results for the 0 to 24 year old cohort in the Beaumont-Hague district. The results of the case study [2] indicate three types of behaviour statistically associated with an increase in the leukaemia risk: those involving frequenting local beaches, those involving the consumption of local fish and seafood and residents in a house built of granite or located on a granite subsoil. These aspects are given due consideration in the Nord-Cotentin 2000 exercise described below.

3. THE NORD-COTENTIN 2000 EXERCISE

3.1 The importance of the operation for local organisations

For the “Angry Mothers” Collective, organising the participation of mobile radiological laboratories from all over Europe constitutes a way of extending and broadening the work of the Nord-Cotentin Radioecology Group and fostering direct involvement of the population. The presence of measurement teams in the Cotentin peninsula also constitutes a cultural event and a manifestation of a high degree of solidarity. For the CSPI, this event constitutes an opportunity for participating in a key independent action involving the supply of information, which is totally consistent with its desire for openness and broad-based expert appraisal, in which the representativeness of the “Angry Mothers” Collective will assist in achieving active participation of the local population. Indeed, for the local population, it will be an opportunity to meet scientists from many different European countries and will constitute an intercultural event of the highest importance.

3.2 The importance of participation by European teams

Ten of the fifteen European institutions contacted agreed to represent their country with a mixed team of six persons in partnership with other laboratories. For the teams, this represents an opportunity for testing their ability to make measurements in the field and comparing the different techniques employed. This encounter will enable an exchange of experience and strengthen links between the

laboratories entrusted with the task of monitoring radioactivity or taking action in the event of an accident. And they will be able to become acquainted in some degree with the local population.

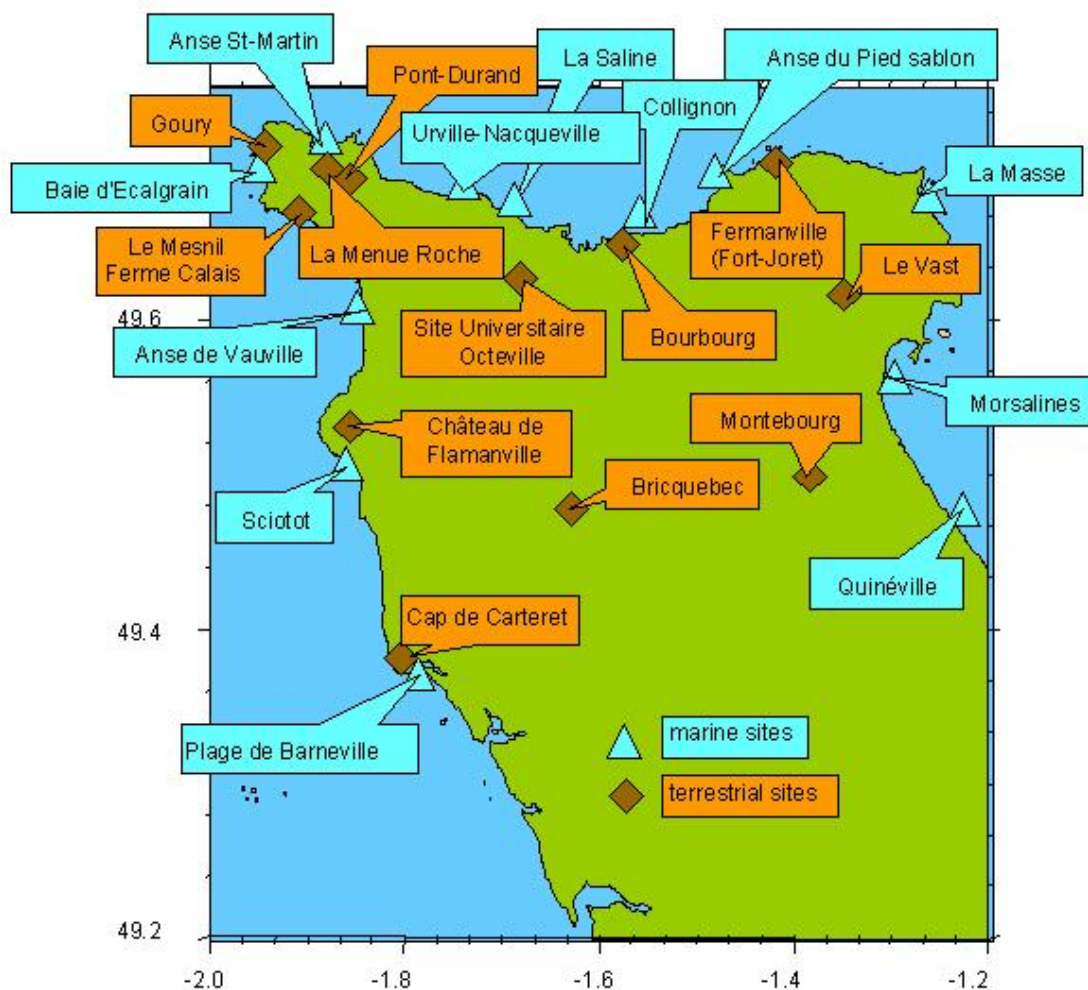
3.3 Measurement programme

The scientific goal of the Nord-Cotentin 2000 exercise is to more fully characterise the study sites. The measurements involve:

- *In-situ* gamma spectrometry [3] for rapid estimation of gamma concentrations and their individual contributions to internal exposure of the public at beaches and selected in-land sites (Figure 1).
- Additional field and laboratory measurements of environment samples (air, soil, water and plants) to supplement *in-situ* gamma data with analysis of specific radionuclides such as ^{85}Kr , ^{14}C , ^{90}Sr , ^3H , ^{129}I , ^{210}Po , $^{239/240}\text{Pu}$, ^{241}Am and ^{244}Cm .

The teaching goal of the Nord-Cotentin 2000 exercise involves making analyses on private premises and in association with schools. Apart from the above measurements, this is to include:

- Measurements in dwellings (dose rate, radon and house dust)
- Analyses of samples of private material and the human body

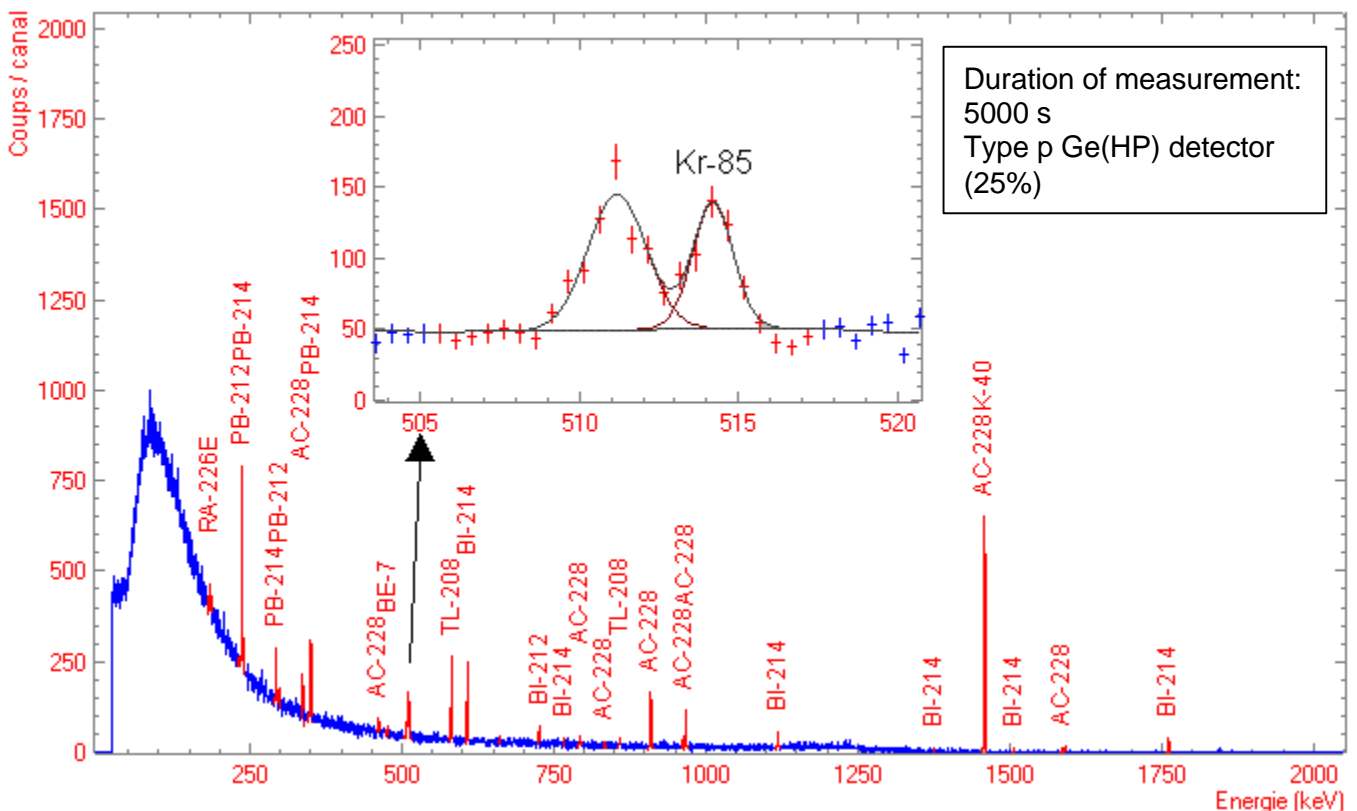


coastal sites ; in-land sites

Figure 1: Coastal and in-land study sites; la Anse de Vauville and le Château de Flamanville are measurement comparison sites.

3.4 Preliminary results

As the exercise took place from 9 to 14 October 2000, only the results of the measurements made directly in the field can be given here. The results of the analysis of individual radionuclides in environmental samples will be provided by the laboratories at a later stage, as a result of the preparatory work (drying, calcination and radiochemistry) required for measurement of the trace quantities involved. By way of an example, Figure 2 shows a field gamma spectrum and the associated results recorded during a preliminary campaign carried out in the north of the Cotentin peninsula by the Federal Office for Public Health in cooperation with the “Angry Mothers” Collective. Apart from natural contributions and remnant ^{137}Cs , the presence of ^{85}Kr shows the effect of releases from the Cogema-La Hague reprocessing complex. The environmental samples taken during the preliminary campaign also revealed traces of ^{129}I in algae and of ^{60}Co and ^{244}Cm in sediments (Figure 3). Similarly, for the isotopes ^{241}Am and $^{239/240}\text{Pu}$, the variability of the isotopic ratios tends to confirm that contamination by releases from the facility is low.



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Radionuclide	^7Be	^{40}K	Series ^{232}Th	Series ^{238}U	^{137}Cs	^{85}Kr
Concentration	80 ± 40 Bq/m ²	270 ± 10 Bq/kg	16 ± 1 Bq/kg	12 ± 1 Bq/kg	< 0.9 Bq/kg	500 ± 50 Bq/m ³
Dose rate	0.02 ± 0.01 nGy/h	11.3 ± 0.4 nGy/h	9.7 ± 0.6 nGy/h	5.5 ± 0.5 nGy/h	< 0.15 nGy/h	0.32 ± 0.03 nGy/h
Calculated total dose rate = $0.02 + 11.3 + 9.7 + 5.5 + 0.32 + 32$ (cosmic) = 59 ± 2 nGy/h						
Total dose rate measured with ionisation chamber (R & Stokes) = 61 ± 2 nGy/h						

Figure 2: Field gamma spectrum recorded at Calle de Chantereynes, on 30 October 1998, and associated analysis results. Consistency between the dose rate calculated with the spectrum and that measured with the ionising chamber was found to be good ($\pm 3\%$).

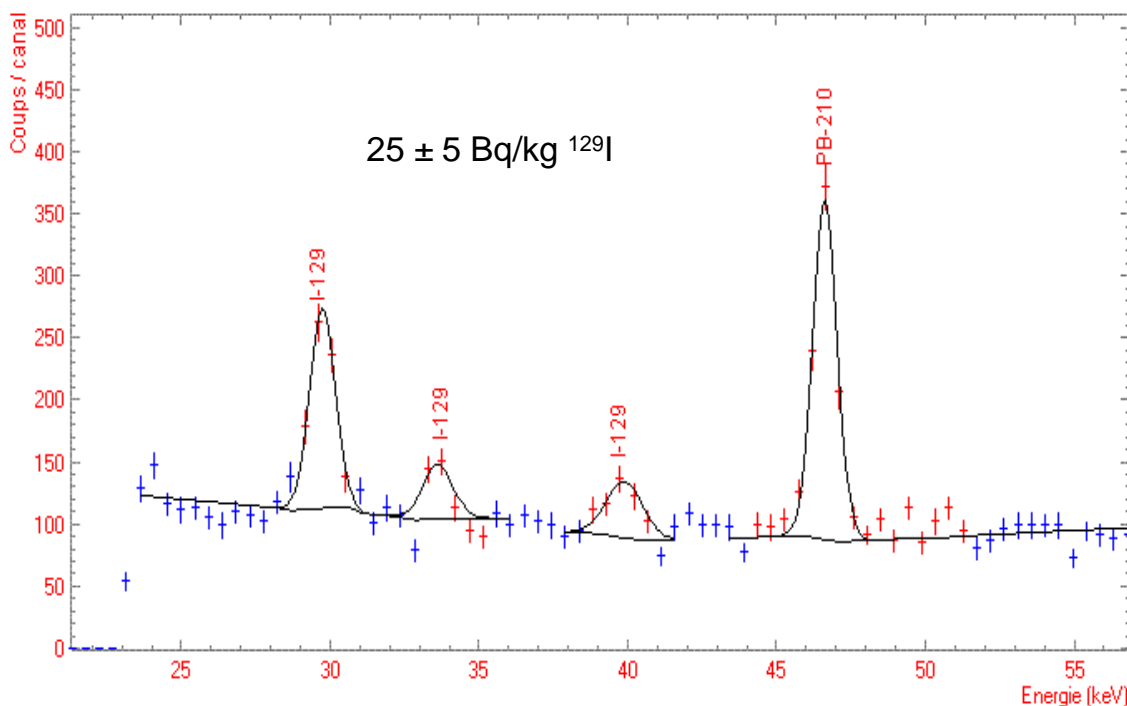


Figure 3: Gamma spectrum recorded on a dry algae sample taken at Calle de Chantereynes, on 30 October 1998.

4. CONCLUSIONS

As this contribution was written before the Nord-Cotentin exercise was carried out, no comments on the findings can be made. However, the presentation to be made at the Eurosafe meeting should include an update on the technical and sociological aspects of the event. The information will therefore be fresher. For the time being, what is striking is the interest aroused by this measurement campaign in both the local population and mobile measurement laboratory organisations. It only remains to be hoped that the results in terms of science and training will be worthy of the effort invested.

"The most incomprehensible thing in the world is that the world is comprehensible" (Einstein). The measurement of radioactivity, however complex it may be, must be the subject of an objective, responsible and understandable supply of information to the public. This is one of the main primary goals of the Nord-Cotentin 2000 exercise. "Knowledge has no intrinsic value, the question is always knowledge for whom and for what?" (Georges Haldas).

Reference material

[1] Nord-Cotentin Radioecology Group, Estimation of exposure levels to ionizing radiation and associated risks of leukemia for populations in the Nord-Cotentin, 1999. The documents produced by the Group may be consulted on Internet: www.ipsn.fr/nord-cotentin

[2] D. Pobel, J.-F. Viel, Case-control study of leukemia among young people near La Hague nuclear reprocessing plant: the environmental hypothesis revisited, *Brit. Med. Journal* 314 (1997) 101-106

[3] Gamma-ray Spectrometry in the Environment, ICRU Report 53, 1994