
Crisis management: Respective roles of radiological consequences calculations and of radioactivity measurements in the environment

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Abstract:

Nuclear emergency exercises show up notably the need to clarify the role of environmental radioactivity measurements in the decisions taken by the national or local authorities concerning the protection of the population. The actions scheduled in the Offsite Emergency Preparedness & Response Plan of the authorities are preventive actions which must be implemented as soon as they appear necessary. There is an urgent necessity of using calculation tools in order to anticipate the evolution of the accident and protect efficiently the populations exposed. Actually, measurements of radioactivity in the environment do not allow the evolution of the situation to be predicted, and waiting for the results of measurements in order to decide on protection actions would seriously compromise their effectiveness. Nevertheless environmental radioactivity measurements are indispensable as soon as the national emergency organisation has been set up to confirm, in addition to the expertise on the state of the installation, whether or not a release has occurred. During the releases and the first hours of the post-accident phase, measurements are required notably to monitor the level of the emissions, determine what are the radionuclides involved, to enable the authorities to adapt or to complement the actions undertaken or envisaged for the protection of the population, to contribute to the decisions to be taken from the withdrawal of the sheltering order.

1 INTRODUCTION

For many years nuclear emergency exercises have been organized periodically in France. They concern mainly nuclear installations and radioactive material transportation with the special aim of testing and improving all the aspects of the corresponding crisis organization. Some exercises, such as those performed on the site of Tricastin NPP (Drôme department) in November 2004 and at Belleville NPP (Cher department) in March 2005, have provided precious preliminary insights in the framework of the ongoing French study regarding post-accident situation management.

Some of the insights are particularly relevant to the role of environmental radioactivity measurements in the decisions taken by the national or local authorities concerning the protection of the population and information on the consequences of the accident.

As soon as the alert has been triggered, specialised teams originating from the nuclear operator and from local authorities are used to take measurements of radioactivity (also measurements of chemical substances, if need be) in the environment. However, both exercises showed up delays of several hours for taking measurements and transmitting the results to the local operational managers and to the national authorities in charge of crisis management supervision.

The lack of measurement results was perceived by the authorities, at both national and local level, as an obstacle to rapid decision making on protection of the population and the environment.

This difficulty shows up the need to clarify the role of radioactivity measurements in the environment during the emergency phase and at the beginning of the post-accident phase when the releases have stopped.

2 RADIOACTIVITY MEASUREMENTS IN THE ENVIRONMENT ARE NOT A PRELIMINARY TO DECISIONS ON PROTECTION OF THE POPULATION

2.1. Decisions relating to the protection of the population: before and during releases

To meet the population's need for protection during an accident situation arising in a nuclear installation, the authorities have drawn up an emergency plan adapted to the risk characteristics of the installation and to the particular demographic, topographic, social and economic features of its immediate surroundings. In France this plan is called the *Plan Particulier d'Intervention* (i.e. Offsite Emergency Preparedness & Response Plan). It includes in particular the implementation of actions for the protection of neighbouring populations, which vary according to the nature and the magnitude of the possible radioactive (chemical) releases: sheltering, evacuation, and absorption of stable iodine in case of radioactive iodine releases. The actions scheduled in the Offsite Emergency Preparedness & Response Plan of the authorities are preventive actions which must be implemented as soon as they appear necessary. With this aim, the Prefect of the Department, as director of rescue operations at departmental level, sets the plan in motion. If a sufficiently long time elapses between the alert from the operator and the first releases, the necessary actions for protection of the population would be started even before releases occur.

What would the authorities base their preventive decisions on? As soon as the alert is given by the nuclear installation operator, the authorities together with the operator set up a crisis organisation in order to control the accident and, if necessary, to start up actions for the protection of the population. Certain accident situations may rapidly lead to releases requiring protection actions within a short time.

Thus, regarding emergency actions for the protection of populations, two cases may arise:

1st case. There is a sufficiently long time (more than 6 hours) between the alert given by the operator and the first releases: the Prefect sets in motion the Offsite Emergency Preparedness & Response Plan in what is called "concerted" mode. This decision would be taken in direct dialog with the Nuclear Safety Authority, after expert calculations forecasting the doses likely to be sustained, without protection action, by the populations exposed to the radioactive plume.

2nd case. There is a short time (less than 6 hours) between the start of the accident and the possible occurrence of releases: the Prefect sets in motion the Offsite Emergency Preparedness & Response Plan in what is called "reflex" mode, based on technical criteria previously established from the safety analyses of the installation.

2.2. Decision to ban the consumption and sale of contaminated foodstuffs: during or after the releases

After the Chernobyl accident in April 1986, the European Community adopted a regulation¹ including the immediate application, in the event of another nuclear accident, of maximum admissible levels (MALs) of radioactive contamination in foodstuffs and animal feed.

¹ Modified EURATOM regulation No. 2218/89 of the Council of 18 July 1989

The MALs were originally set to harmonise the international trade in food products. They are based on concerns about consumer health protection. These MALs would therefore be taken into consideration by the French authorities to limit consumption of products originating from contaminated areas.

In this context, the Prefect can issue, during or rapidly after the releases, a decree temporarily banning the consumption and sale of these foodstuffs in certain districts around the nuclear installation.

However, it is difficult, or even impossible, to effect sufficient radioactivity measurements in a short time to allow for an exhaustive assessment of the level of contamination in foodstuffs; the possible decision to ban would be based on a contamination forecast, performed by *IRSN* using mathematical models. Given the level of soil contamination, these models, including radioecological parameters, provide the food contamination levels for various types of food and radionuclides. This forecast would help to establish the perimeter of the zone in which maximum admissible levels are exceeded and the duration of the banning. In a later phase, the results of the measurement would allow for a progressive consolidation of the assessment and, if necessary, a scaling down of the restrictions first ordered as a preventive action (see below).

3 RADIOACTIVITY MEASUREMENTS IN THE ENVIRONMENT ARE HOWEVER INDISPENSABLE

The foregoing considerations show up the urgent necessity of using calculation tools in order to anticipate the evolution of the accident and protect efficiently the populations exposed. Actually, measurements of radioactivity in the environment do not allow the evolution of the situation to be predicted, and waiting for the results of measurements in order to decide on protection actions would seriously compromise their effectiveness.

Nevertheless, taking these measurements is indispensable:

- As soon as the national emergency organisation has been set up following the alert given by the operator, teams of firemen as well as the operator's teams are dispatched to the area near the installation according to predefined circuits. They take measurements using equipment items which enable them to measure the nature and level of radiation associated with the radionuclides released. In addition to the expertise on the state of the installation and the conclusions which result from it concerning the possible existence of a release, these measurements are particularly useful to:
 - confirm that the release has not yet occurred if the ambient radioactivity is no different from the natural background radiation;
 - confirm, if that is the case, that a release is in progress.
- During the release and in the first hours of the post-accident phase, as soon as there are enough available of sufficient quality, the measurements would in particular be used, along with estimations based on dispersion models, to:
 - monitor the level of the emissions and in some cases to determine what are the radionuclides involved;

- back up or modify the assessments of the event's consequences on the population and the environment, to enable the Prefect to adapt or to complement the actions already undertaken or envisaged for the protection of the population and the restriction on the consumption and sale of contaminated foodstuffs
- contribute to the decisions to be taken from the withdrawal of the sheltering order. As far as living conditions are concerned after the withdrawal of the sheltering order, the measurements must help in the assessment of whether it is possible for people to stay in their homes, taking a minimum of precautions, or alternatively, if it is necessary for them to provisionally leave the affected zone. At first, the decision will essentially be based on model forecasts of exposure; progressively, these forecasts will be consolidated from the increasingly numerous measurement results.

4 RADIOACTIVITY MEASUREMENTS IN THE ENVIRONMENT NEED TIME

Obtaining the first reliable and interpretable measurement results requires several hours, on account of the time necessary:

- to bring the measurement teams to the area affected by the releases,
- for the teams to cover the measurement circuits,
- to take and pack the samples,
- to set up the equipment items,
- to transmit the results to the Prefecture and to the National Emergency technical centres,
- to analyse the results so as to ensure correct interpretation.

Finally, the nature of the measurements performed will significantly influence these time factors:

- measurements of ambient radioactivity (external exposure) can be performed quickly (in one to a few hours) once the teams are in place,
- gamma spectrometry measurements require 4 to 10 hours.
- alpha measurements, more than one day.

5 CONCLUSION

It would appear to be essential to explain to the parties involved that the results of the measurements provide no directly exploitable information concerning the doses which the population might sustain or on concentrations in foodstuffs. For forecast estimation of doses and concentrations in foodstuffs, calculation remains indispensable. Radioactivity measurements are nevertheless useful to back up or to modify the assessments obtained by calculation.

Work is currently undergone in France in view of better organizing the overall measurement process: What type of measurement according to the accident situation? Where to measure in the urban and rural zones? When, according to the various objectives of the measurements? Which measurement and sampling protocols? Which field actors and which laboratories? Which procedures for data gathering and dispatching of the results?

It is useful to produce arguments for dissemination of information on the question of measurements, emphasizing in particular:

- the necessity of using models to calculate doses and concentrations in foodstuffs, as the results of measurement support and complement these models,
- the type of measurement necessary according to the types of accident and the phases of the accident,
- the time needed to obtain the results, in particular of sample analysis,
- the necessity, in view of the exploitation of the measurement results, of correlating them, as they will inevitably include inconsistencies².

² Given the variability of meteorological phenomena, atmospheric dispersion phenomena in a built-up environment, the fluctuations of deposits on diverse surfaces, but also the possible saturation of measuring devices and the inevitable errors in the entry of results, even of units, etc.