EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear energy, safety and ITER
D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

FRANCE

La Hague nuclear site

Environmental radioactivity monitoring arrangements
Emergency radioactivity monitoring arrangements

29-31 May 2018

Reference: FR 18-01

VERIFICATION UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES	Environmental radioactivity monitoring arrangements at the La Hague site Emergency radioactivity monitoring arrangements at the La Hague site
LOCATIONS	La Hague nuclear fuel reprocessing facility, France
DATES	29-31 May 2018
REFERENCE	FR 18-01
TEAM MEMBERS	Mr V. Tanner (team leader) Mr R. Van Ammel
REPORT DATE	30 November 2018
SIGNATURES	

V. Tanner R. Van Ammel

TABLE OF CONTENTS

ANNEXES

ABBREVIATIONS

ARS	Regional Health Agency
ASN	Nuclear Safety Authority
CTE	Euratom Technical Committee (France)
DDCSPP	Departmental Directorate for Social Cohesion and Public Protection
DDI	Interministerial Departmental Directorate
DDPP	Departmental Directorate for Public Protection
DDSV	Departmental Directorate of Veterinary Services
DGAL	Directorate-General for Food at the Ministry of Agriculture, Food, Fisheries, Agri-Food and Forestry
DGCCRF	Directorate-General for Competition, Consumer Affairs and Fraud Prevention at the Ministry of the Economy, Industry and the Digital Sector
DGDDI	Directorate-General for Customs and Indirect Taxes
DGPR	Directorate-General for Risk Prevention at the Ministry of Ecological and Solidarity Transition
DGS	Directorate-General for Health at the Ministry of Solidarity and Health
DGSCGC	Directorate-General for Civil Protection and Crisis Management
DIRECCTE	Regional Directorate for Enterprise, Competition, Consumer Affairs, Labour and Employment
DPSN	Protection and Nuclear Safety Directorate of the CEA (French Alternative Energies and Atomic Energy Commission)
DREAL	Regional Directorate for the Environment, Planning and Housing
EC	European Commission
EU	European Union
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
IRSN	Institute for Radiation Protection and Nuclear Safety
LT2E	Remote Detection and Environmental Laboratory at the IRSN
MPL	Maximum Permissible Level
PRPDE	Person responsible for water production and distribution
RNM	National Network for Environmental Radioactivity Measurements
SCL	Joint Laboratories Service of the Ministry of the Economy, Finance and Industry
SIRSE	Radiological Response and Environmental Monitoring Service at the IRSN
SGDSN	General Secretariat for Defence and National Security
SPR	Service for Protection against Radiation
TLD	Thermoluminiscent dosimeter

TECHNICAL REPORT

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards[1]. Article 35 gives the European Commission (EC) the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The Joint Research Centre Directorate-General provides technical support during the verification visits and in drawing up the reports.

The main purpose of the verifications under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant exposure pathways;
- levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified France of its decision to conduct an Article 35 verification in a letter addressed to the France Permanent Representation to the European Union (EU). The French Government subsequently designated the Comité Technique Euratom (CTE) to lead the preparations for this visit.

2.2 DOCUMENTS

To assist the verification team in its work, the national authorities supplied a documentation package in advance[3]. Additional documentation was provided during and after the visit. The information thus provided was used extensively in drawing up the descriptive sections of the report.

The La Hague site has been subject to an Article 35 verification previously in 2005[4]. This verification addressed both environment and discharge monitoring issues, although with different target facilities.

---

1 Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018 (OJ L 13 of 17.1.2014).

2 Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006, pp. 2-5).

3 Replies to the preliminary information questionnaire addressed to the national competent authority, received on 9 May 2018.

4 Art. 35 Technical report F-05/6 – Vérification au titre de l'article 35 du traité Euratom, Usine de traitement des combustibles nucléaires usés La Hague, département de la Manche (Nord-Cotentin), région de la Basse Normandie, France, du 10 au 14 octobre 2005.

2.3 PROGRAMME OF THE VISIT

The Commission and the CTE discussed and agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006.

In the opening meeting, the following topics were presented and supporting documentation was provided to the verification team:

- Le réseau national de mesures de la radioactivité de l'environnement (RNM) – Nathalie Reynal (ASN)
- L'agrément des laboratoires – Marc Fournier (ASN)
- Présentation générale du groupe Orano et du site de La Hague (Orano)
- L'encadrement réglementaire des rejets liquides et gazeux du site de La Hague et de la surveillance de l'environnement - Gabriel Plancque (ASN)
- Site Orano Cycle de La Hague: rejets et surveillance de l'environnement – Loïc Cardin (Orano)
- La surveillance de l'environnement par l'IRSN – Maxime Morin (IRSN)

The verification team pointed to the quality and comprehensiveness of all the presentations and documentation.

The team carried out the verifications in accordance with the programme in Appendix 1. The representatives of the national authorities and other parties presented in the table below were involved in the verifications.

List of participating personnel

29 May	30 May	31 May
Vesa Tanner - EC		
Raf Van Ammel - EC		
Eugénie Vial - CTE		
Nathalie Reynal - ASN		
Gabriel Plancque – ASN		-
Marc Fournier - ASN	Corinne Fayolle – ASN	
Hélène Héron – ASN Caen	Laurent Palix – ASN Caen	Hélène Héron – ASN Caen *(après-midi)*
Maxime Morin – IRSN		
Michaël Petitfrère – IRSN		
Michel Baudry - IRSN	-	-
Sabrina Lepeltier – ARS Normandie	Jean Bodin – ARS Normandie	-
Patrick Devin – Orano Cycle La Défense		
Christophe Ray – Orano Cycle La Hague		
Loïc Cardin – Orano Cycle La Hague		
Alain Lavenu - Orano Cycle La Hague	-	-
René Charbonnier - Orano Cycle La Hague	-	-
Michel Gourlay - Orano Cycle La Hague	-	-
Julie Demeestere - Orano Cycle La Hague		-

3 COMPETENT BODIES IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING IN FRANCE

3.1 INTRODUCTION

The environmental radiological measurements carried out by the various organisations in France have three main, complementary objectives:

- to verify whether nuclear activities are being carried out in compliance with the regulations/legal framework applicable to them, in particular as regards discharges from installations, and the monitoring of the installations' impact resulting from the declared discharges;
- to ensure that the territory and all constituent parts remain in satisfactory radiological condition so that persons or ecosystems do not receive excessive exposure;
- to detect quickly and characterise any increase in radioactivity that may be the result of an incident or accident involving radioactive substances.

Monitoring at the La Hague site and in its vicinity includes these objectives and puts them into practice at local level. It involves the participation of many organisations, as outlined below.

3.2 ENVIRONMENTAL RADIOACTIVITY MONITORING

3.2.1 Organisations involved

At national and local level, several organisations participate in environmental radioactivity monitoring:

- Ministries:
  - Ministry of the Ecological and Solidarity Transition, whose Directorate-General for Risk Prevention (DGPR) includes a technological risks department (responsible, among other things, for radiological risks), and a department for preventing environmental harm and safeguarding environmental quality;
  - Ministry of Solidarity and Health, whose Directorate-General for Health (DGS) is in charge of policy for preventing and managing risks linked to lifestyles and diet. The DGS is responsible for protecting the public as regards the various uses of water (drinking water, recreational waters, domestic hot water, bottled water, wastewater, etc.). It coordinates, inter alia, the local water quality monitoring networks managed by the Regional Health Agencies (ARS);
  - Ministry of Agriculture and Food, whose Directorate-General for Food (DGAL) is responsible for supervising the quality and safety of foodstuffs intended for human and animal consumption. The DGAL's remit focuses on the safety and quality of the agri-food chain;
  - Ministry of the Economy and Finance, whose Directorate-General for Competition, Consumer Affairs and Fraud Prevention (DGCCRF) is in charge of overall market surveillance.
- State services and other public bodies responsible for monitoring the national territory or specific sectors (i.e. the Ministry of Agriculture monitors foodstuffs, the Directorate-General for Health monitors drinking water). This includes twelve Regional Directorates for the Environment, Planning and Housing (DREAL) across the country, which are under the authority of the prefect of the region concerned and are responsible, among other things, for developing and implementing State policies on the environment and sustainable planning and development.

- The Nuclear Safety Authority (ASN) is an independent administrative authority that participates in monitoring nuclear safety, radiation protection and nuclear activities, as well as in providing public information and ensuring transparency in the areas within its remit. Pursuant to the Environmental Code (L. 592-1) the ASN has the following specific environmental responsibilities:
  - organising permanent monitoring in the area of radiation protection, including environmental radioactivity monitoring across the entire country;
  - regulating and monitoring discharges of gaseous and liquid effluents and waste from basic nuclear installations (INBs), such as the seven INBs at the La Hague site;
  - proposing, coordinating and implementing the regulatory and control policy for environmental monitoring of nuclear sites;
  - approving laboratories to perform environmental radioactivity monitoring.
- The Institute for Radiation Protection and Nuclear Safety (IRSN) is a public State body that provides expertise and carries out research in the field of nuclear security[5]. It participates in permanent radiation protection monitoring, takes part in environmental radiation monitoring and manages and uses dosimeter data of workers exposed to ionising radiation.
- Approved air quality monitoring associations (local authorities), environmental protection associations, and local information committees (bodies responsible for scrutiny, information provision and dialogue in relation to nuclear installations).
- Operators of nuclear installations carry out monitoring near their sites pursuant to legislation or regulations. With specific regard to La Hague, Orano Cycle is the operator in charge of monitoring on the site and in its environment in line with the conditions laid down in the administrative authorisations linked to the site and its installations.

3.2.2 National Network for Environmental Radioactivity Measurements

The National Network for Environmental Radioactivity Measurements (RNM) brings together all the parties carrying out environmental monitoring activities. Its main aim is to gather and publish all environmental measurements carried out on the national territory. Quality of the measurements is guaranteed by a procedure for approving laboratories to analyse radioactivity in different media. Authorisations are issued by the ASN after a multi-party authorisation committee has given its positive opinion. This committee is chaired by the ASN and brings together representatives of the main ministries (environment, health, food, consumer affairs and defence), experts, representatives of laboratories and representatives of the IRSN. It generally meets twice a year. In accordance with the provisions of ratified decision No 2008-DC-0099 of the ASN of 29 April 2008, as amended by ratified decision No 2015-DC-0500 of 26 February 2015, the committee issues its proposals for approval of laboratories on the basis of:

- the approval application file, in which the laboratory must provide evidence that its practices are in line with the organisational and technical requirements laid down by standard NF EN ISO/CEI 17025;
- the laboratory's results in the inter-laboratory comparison tests, organised by the IRSN according to a multi-annual programme.

[5] Under Article L. 591-1 of the Environmental Code, nuclear security includes nuclear safety, radiation protection, preventing and combatting malicious acts and civil protection activities in the event of accidents.

The approval committee also gives its opinion on the programme of inter-laboratory comparison tests, drawn up by the IRSN in consultation with the ASN, the technical criteria for assessing laboratories' results in the tests and the quality criteria making it possible to judge whether the laboratory applying for approval complies with the standard-based requirements applying to test laboratories.

3.3 RADIOLOGICAL SURVEILLANCE OF FOODSTUFFS

The Directorate-General for Competition, Consumer Affairs and Fraud Prevention (DGCCRF) at the Ministry of the Economy and Finance is in charge of overall market surveillance. It supervises the quality and safety of foodstuffs of non-animal origin. It exercises its powers at all stages of the food chain, except for primary production, which falls within the remit of the DGAL at the Ministry of Agriculture and Food.

Across the country, the DGCCRF is supported by two networks of decentralised services:

- at regional level, 13 Regional Directorates for Enterprise, Competition, Consumer Affairs, Labour and Employment (DIRECCTE), five DIRECCTEs in overseas France and one Directorate for Social Cohesion, Labour, Employment and the Population in Saint Pierre and Miquelon;
- at departmental level, 96 interministerial departmental directorates (DDIs): i.e. Departmental Directorates for Public Protection (DDPPs) in departments with more than 400 000 inhabitants and Departmental Directorates for Social Cohesion and Public Protection (DDCSPPs) in departments with less than 400 000 inhabitants.

The Directorate-General for Food (DGAL) at the Ministry of Agriculture and Food has a complementary role and is responsible for supervising the quality and safety of foodstuffs. It guarantees the food safety, which takes in account also the radiological risk. Its remit covers primary animal and plant production, foodstuffs (including processed foodstuffs) of animal origin, imports of foodstuffs of animal origin intended for human consumption and animal feed whether of animal or plant origin.

Across the country, the DGAL is supported by two networks of decentralised services:

- at departmental level: the Departmental Directorates for Public Protection (DDPPs) in the more highly populated departments and the Departmental Directorates for Social Cohesion and Public Protection (DDCSPPs), which are responsible for food quality and safety and animal health and welfare;
- at regional level: the regional plant protection services of the Regional Directorates for Agriculture and Forestry (DRAAFs), which are in charge of protecting plant health.

3.4 RADIOLOGICAL SURVEILLANCE OF DRINKING WATER

The Directorate-General for Health (DGS) at the Ministry of Solidarity and Health is responsible for developing the legal framework on the quality of water intended for human consumption and for evaluating and coordinating the implementation of it by the Regional Health Agencies (ARSs).

Water intended for human consumption is subject to regular monitoring, including its radiological quality, to guarantee its quality. This monitoring includes:

- monitoring carried out by the persons responsible for water production and distribution (PRPDEs), i.e. mayors, chairpersons of collective public bodies producing or distributing water, or private operators entrusted with managing the water service;
- water quality monitoring carried out by the ARSs completely independently of the PRPDEs.

Water samples taken as part of quality monitoring activity are analysed by laboratories approved by the Ministry of Solidarity and Health. The ASN is responsible for examining the application files concerning analyses for radiological quality monitoring of water intended for human consumption.

After consulting the IRSN, ASN sends its opinion to the DGS, which is responsible for issuing the approval. The ASN is also consulted on all draft amendments to the legislation concerning the radiological quality of water intended for human consumption.

3.5 RADIOLOGICAL SURVEILLANCE OF LIQUID AND GASEOUS DISCHARGES

Monitoring discharges from a basic nuclear installation (INB) is the responsibility of the installation's operator according to the regulation (order of 7th February 2012 setting the general rules relative to basic nuclear installations). It is governed by two levels of authorisation:

- limits for discharges into the environment of liquid and gaseous effluents, which are set for each INB by a decision of the ASN ratified by the Ministry of Ecological and Solidarity Transition;
- procedures and conditions for the intake and consumption of water and discharge into the environment of liquid and gaseous effluents specified by decision of the ASN.

The rules governing discharges specify the minimum checks that the operator must carry out. This monitoring is carried out on liquid and gaseous effluents (monitoring the radioactivity of discharges, characterising certain effluents before discharge, etc.) and on the environment in the vicinity of the installation (checks during discharge, sampling of air, water, milk, grass, etc.). The findings of this monitoring are entered in registers and sent to the ASN each month.

In addition, the INB operators regularly send a certain number of discharge samples to an independent laboratory for comparative analysis. The results of these crosschecks are sent to the ASN. This programme of crosschecks makes it possible to ensure that the measurements carried out by the operators' laboratories are correct.

The ASN carries out dedicated inspections to ensure that operators are properly complying with the regulatory provisions applicable to them concerning the management of discharges. Some of them (10 to 20 inspections per year on the whole national territory) include sampling operations for realizing contradictory analyses. These inspections are generally unannounced and carried out with the support of specialised independent laboratories commissioned by the ASN. Samples of effluents and samples in the environment are taken for the purpose of radiological and chemical analyses.

3.6 NUCLEAR AND RADIOLOGICAL EMERGENCY PREPAREDNESS

France has a system for managing major crises under the authority of the Prime Minister. Each minister is responsible for preparing and implementing the defence and national security measures within the remit of their department.

The prefects of defence and security zones, who are the representative of the State within their zone, have analysing, forecasting and planning capacity. It enables them to coordinate the parties involved and resources deployed. They are tailored to the characteristics and vulnerabilities of the zone concerned. In addition, the department prefects are responsible for crisis management at local level. They are supported by the various State services and regional health agencies and bring together the operators and local authorities in their department. If a crisis has an international dimension, the zone prefects put in place coordination measures with the involved countries bordering their zone. The governmental arrangements for managing major crises envisage exchanges between States and with the European Commission.

These arrangements, which are in place for all major crises, are adapted as necessary to respond to particular risks or threats. In 2014, France therefore published a national response plan for a major nuclear or radiological accident (PNRANRM), which allows for the provision of specialised radiological risk support, decision-making assistance and resources coordination. This plan makes it possible to coordinate the arrangements with the specific stakeholders. To respond to the radiological risk, in particular the ASN, the IRSN, and, for example, the International Atomic Energy Agency (IAEA) are concerned. It also supplements the arrangements in place for all crises with a special nuclear alert network and ensures the specific provisions concerning transparency and provision of information to

the public on nuclear issues. This national plan, which is broken down into detailed action sheets, is rolled out by the prefects in each defence and security zone and in each department. It makes it possible to strengthen the response nationwide and not only in the immediate vicinity of installations.

Closer to installations, the department prefects supplement these arrangements with off-site emergency response plans. These allow them to act more effectively in the initial stages of a crisis, until the major crisis management arrangements at department, zone and governmental level are set up.

4 LA HAGUE NUCLEAR SITE

4.1 SITE DESCRIPTION

The Orano La Hague facility is located at the north-western tip of the Cotentin peninsula, about 20 km west of Cherbourg (92 000 inhabitants) and 6 km from the end of the cape of La Hague. The facility is located on the territories of the communes of Digulleville, Jobourg, Omonville-la-Petite and Herqueville, in the Beaumont canton of the Manche department.

The north-western tip of the Cotentin peninsula is a rocky cape about 15 km long and 5 to 6 km wide; its average altitude is about one hundred meters; it decreases gently towards the northwest while it ends at the southwest by high cliffs (Jobourg plateau).

The Anglo-Norman island of Alderney, 16 km from the cape of La Hague, delimits, with the latter, the arm of the sea called Raz Blanchard. The sea is shallow (35 m maximum) and the tidal currents very strong (up to 10 knots, or about 5 m/s).

The facility, located at the top of the Jobourg plateau, 180 meters above sea level, covers an area of 230 hectares in one area. To this area, 40 hectares located to the south, in the valley of Moulinets, have been added.

Figure 1. Orano La Hague nuclear site

4.2 RADIOACTIVE DISCHARGES

The La Hague site facilities discharge liquid radioactive effluents to the Atlantic Ocean through a common waste water discharge pipe. Airborne effluents are discharged into the atmosphere at several controlled discharge points. The site operator is in charge of the discharge monitoring, respecting standards and following guidance provided by the regulator, and is subject to inspections. According to the regulation (order of 7th February 2012 setting the general rules relative to basic nuclear installations), the operator implements an annual programme of crosscheck analyses with a third party organisation. In addition, the ASN carries out inspections to control compliance with the regulatory requirements concerning the discharges, some of which imply taking samples of liquid and gaseous discharge for carrying out contradictory analyses by an independent laboratory.

5 MONITORING OF EXTERNAL RADIATION

5.1 MONITORING BY THE PUBLIC AUTHORITIES

5.1.1 Automatic dose rate monitoring

At national level, monitoring of the dose equivalent rate is carried out on the whole territory at the IRSN remote sensing laboratory of the Radiological Response and Environmental Monitoring Service (SIRSE). The automated detectors are proportional counters manufactured by BITT Technology (Austria) (Fig. 2).

Figure 2. BITT Technology detectors used by the IRSN

The main technical features of the detectors are the following:

- measuring range: a few nSv/h to 15 mSv/h;
- calibration with a ^{137}Cs calibration source, (certificate supplied on delivery);
- energy range: 40 keV to 3 MeV;
- ambient temperature range allowing proper operation: -30 °C to 70 °C;
- acceptable relative atmospheric humidity: up to 95 % (IP67);
- average relative uncertainty: 10 %.

Detector characteristics in terms of energy and the direction of incidence of the radiation are depicted in the figure 3. The map in figure 4 shows the location of the detectors around the La Hague site.

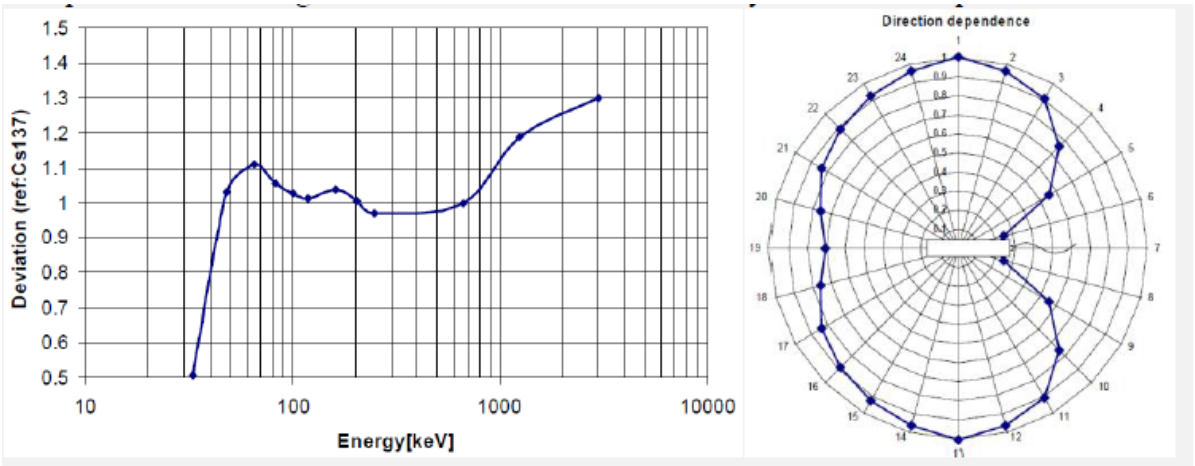

Figure 3. BITT detector characteristics

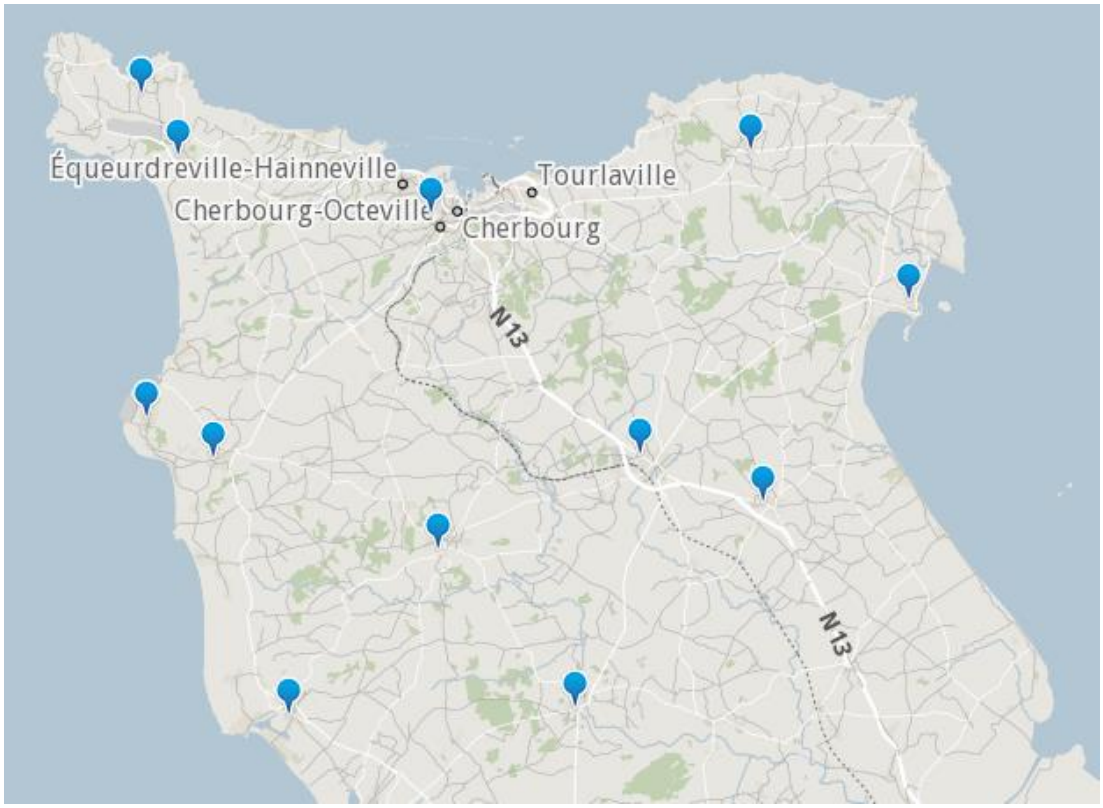

Figure 4. Locations of the IRSN dose rate monitors in the La Hague site vicinity

The measurements of the monitors are transmitted via a multiprotocol label switching virtual private network (MPLS VPN), either under a direct contract between the IRSN and a telecommunications operator or under the agreement between the IRSN and the Gendarmerie Nationale (which also has a contract with a large telecommunications operator).

The monitoring system ensures retrieval of the measurement data in a Microsoft SQL Server database. Each measurement result is automatically compared to a sliding reference average of one week's data. The measurement is automatically validated if it is within the acceptable variation range (±40 nSv/h) of this average reading; in other cases the measurement has to be manually validated by the Téléray remote sensing system team member on call.

The system functions in real time. It incorporates redundancy, has a recovery plan and an agreed service commitment from the network operator.

5.1.2 Passive dosimetry

Monitoring of the public radiation dose through passive dosimetry is carried out using about one hundred dosimeters distributed on the site surroundings. This was previously carried out with diode transistor logic (DTL) dosimeters only. Today monitoring is more and more frequently carried out using radio-photoluminescence (RPL) dosimeters (manufactured by the IRSN's dosimetry laboratory). The dosimeters are replaced every three months.

5.2 MONITORING BY THE OPERATOR

The operator Orano carries out monitoring of the ambient gamma dose rate at the La Hague site and in the environment around the site.

5.2.1 Fence monitoring stations

Eight stations have been installed at the site perimeter fence for continuous monitoring (Fig. 5). The stations are equipped to measure alpha and beta activity in aerosols and ambient gamma dose equivalent rate. The information collected by the fence stations is transferred in real time to the site Environment Command unit via an automated device and a modem. This information thus

contributes to continuous monitoring of the site gaseous discharges. The technical features of this equipment are as follows:

- EcoGamma monitors produced by Mirion;
- quantity measured: Ambient dose equivalent H* (10);
- calibration: ^{137}Cs source;
- measurement range: 10 nSv/h – 10 Sv/h;
- energy range: 30 – 5 000 keV.

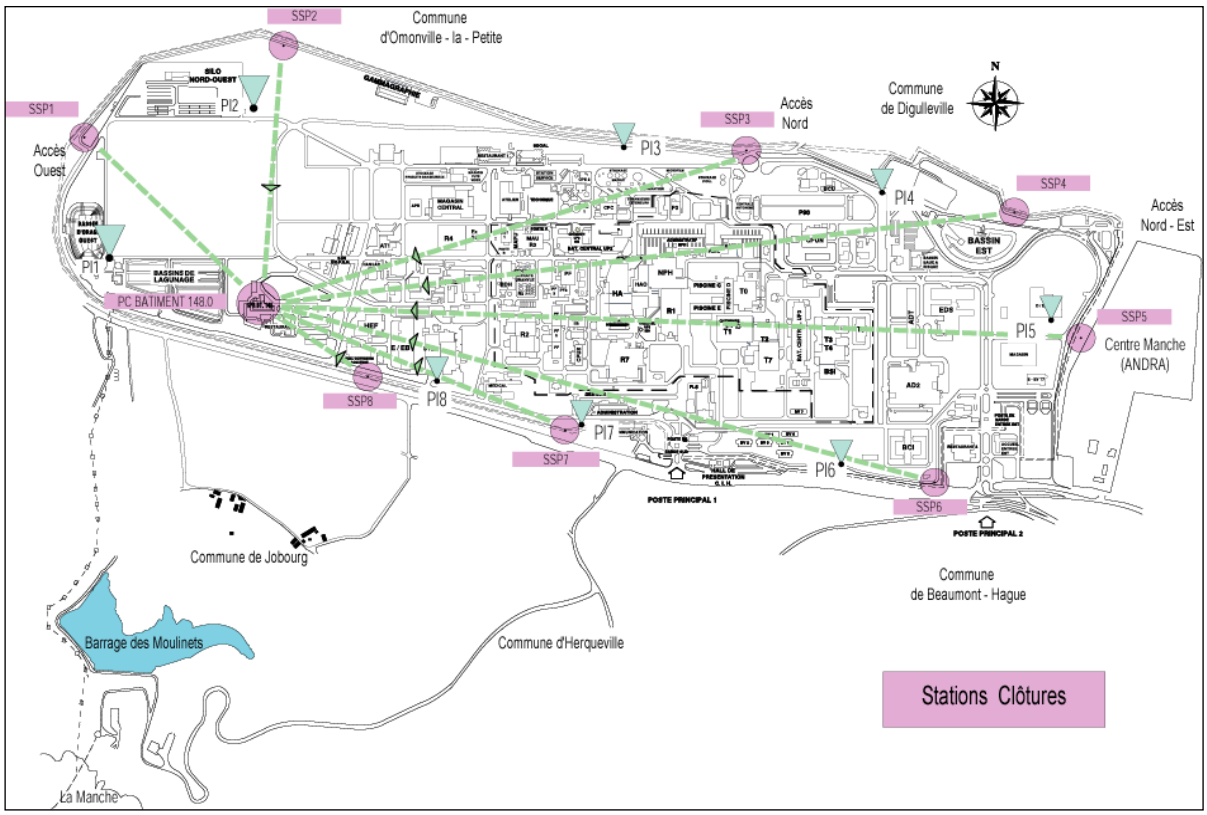

Figure 5. Locations of fence monitoring stations at the La Hague site

Legend	
Stations Clôtures	*Fence stations*

5.2.2 Village monitoring stations

The five 'village stations' (Fig. 6) located between 1 and 6 km from the La Hague site have equipment to continuously measure radioactivity of gases (RADAIR), ambient gamma dose equivalent rate and alpha and beta activity of aerosols. The ambient gamma dose equivalent rate measurement equipment has the following features:

- BGS monitors produced by Mirion;
- quantity measured: Ambient dose equivalent H*(10);
- calibration: ^{137}Cs source;
- measurement range: 50 nSv/h – 3 Sv/h;
- energy range: 100 – 1 250 keV;
- measurement every 3 seconds with an integration time of 1 000 seconds at the processing unit handling the ambient dose equivalent rate.

The information is transferred to the Environment Command unit via an automated device and modem and contribute to continuous monitoring of the site's gaseous discharges. In addition, a device measures the activity concentration of ^{85}Kr at the same location. The monthly average

measurement results of ambient radiation at the village stations are transcribed into the relevant register and sent to the RNM website.

Figure 6. Locations of the Orano village stations

Legend	
Stations Villages	*Village stations*
PC Environnement	*Environment Command unit*

5.2.3 **Passive dosimetry**

Ambient gamma dose is measured at 11 points (Fig. 7) on the site's perimeter fence using passive dosimeters (thermoluminescence). They are exchanged every month. The measurement results sent by the Dosimetry work area (DSSEP/RE/D) are expressed in the quantities defined in Council Directive 96/29/Euratom. The monthly measurement results are entered in the relevant statutory register and sent to the RNM website.

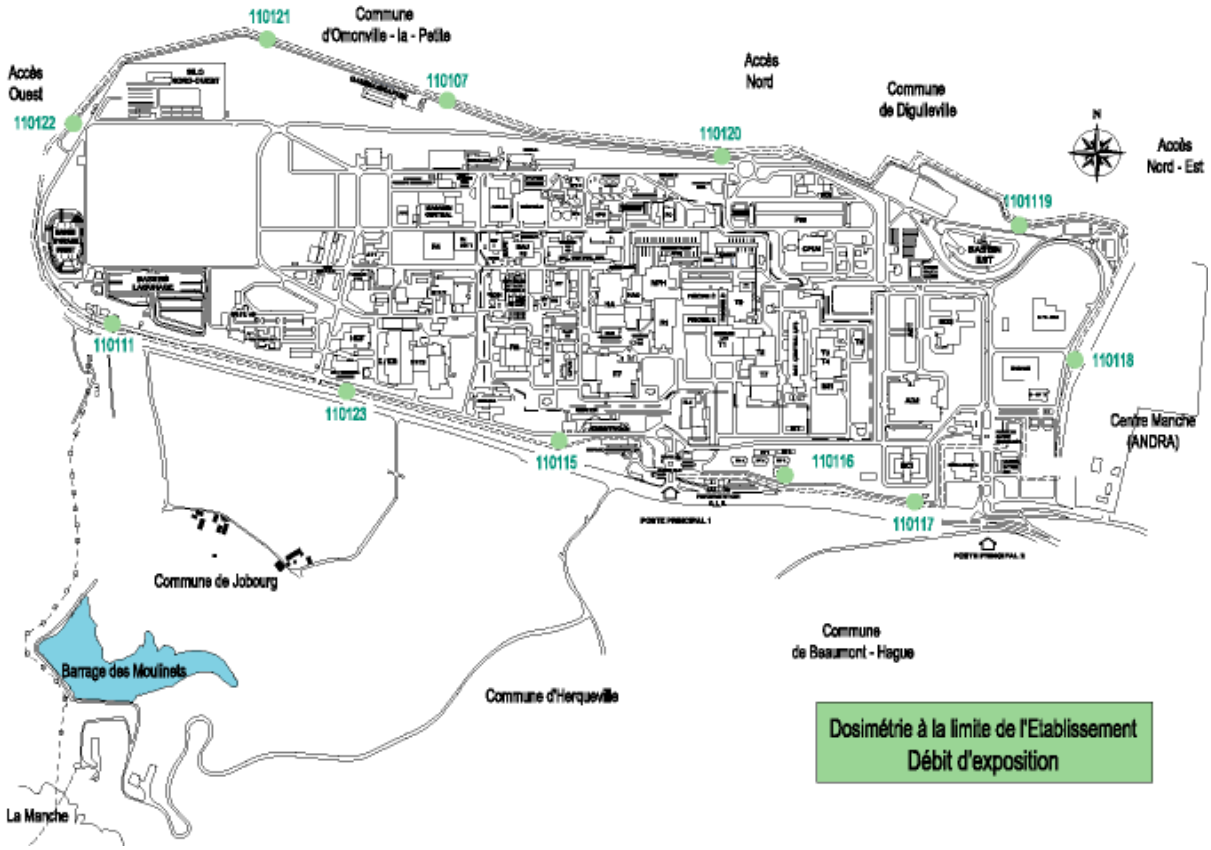

Figure 7. Passive dosimeters at the site fence

Legend	
Dosimétrie à la limite de l'Etablissement	*Dosimetry at the perimeter of the site*
Débit d'exposition	*Exposure rate*

6 MONITORING OF RADIOACTIVITY IN FOOD

6.1 MONITORING BY THE PUBLIC AUTHORITIES

6.1.1 Monitoring of primary products by DGAL

At national level, each year the DGAL, in conjunction with the IRSN, draws up a plan to monitor the presence of radionuclides. The sampling plan covers the following subjects:

- monitoring of products exposed to potential sources of radioactive contamination (areas close to a basic nuclear installation): 91 samples are scheduled for 2018 (19 from the Normandy region, where the La Hague site is located, including 14 milk samples and 1 meat sample from the Manche department);
- light departmental monitoring: characterisation of the radiological quality of foodstuffs (in particular milk) outside the direct influence of basic nuclear installations: 188 samples are scheduled for 2018 (11 from the Normandy region, including 1 from the Manche department);
- monitoring in areas affected by radioactive residues (*zones de remanence*)[*]: 44 samples are scheduled in 2018 (none from the Normandy region);
- coastal monitoring: 13 samples are scheduled for 2018 (6 from the Normandy region, including 3 from the Manche department).

Officials of the Departmental Directorates for Public Protection (DDPPs) or Departmental Directorates for Social Cohesion and Public Protection (DDCSPPs) take samples across the country of the matrices concerned, namely milk, meat in abattoirs, game at hunting sites or processing facilities, honey at beekeepers' premises, fish at sales and distribution sites (auctions, stalls, etc.). Some samples are sent to the IRSN. The main radionuclides tested for are ^{134}Cs and ^{137}Cs. The IRSN carries out extra analyses on the samples sent to it to test for a series of natural and artificial radioactive elements.

In order to ensure representative sampling for certain analyses (particularly taking into account any seasonal random factors), milk sampling may be spread over the year. In such cases, the sample is taken at the same producer for each of the quarterly or half-yearly samples.

Supplementing the sampling of milk at farms situated in the vicinity of nuclear installations, samples from cooperatives or dairies make it possible to obtain representative reference values for a department's overall output of cow, sheep and goat milk and ensure health monitoring on a national scale.

This monitoring also allows a network of competent laboratories to be maintained. This network is vital in the event of a crisis. The sampling frequency (in most cases annual) may be increased in case of a radiological event.

Specific to the Orano La Hague site, three sampling points are situated in Digulleville, where a quarterly sample of milk (3 litres) is taken by the agriculture ministry and sent to the IRSN. It is analysed for free tritium, ^{129}I, ^{14}C, ^{90}Sr and gamma emitters. One sampling point is selected for an annual sample of meat (3 kg) to test for bound tritium, ^{14}C, ^{90}Sr and gamma emitters. As a part of coastal monitoring, three sampling points are situated in the municipalities of Barfleur, Goury and Saint George de la Rivière, where an annual sample of fish (5 kg) is taken to test for bound tritium, ^{14}C, ^{90}Sr, plutonium isotopes, ^{241}Am and gamma emitters.

[*] These '*zones de remanence*' are areas which are affected by nuclear residues as a result of nuclear weapons tests between 1950 and 1980 and the passage of the Chernobyl radioactive cloud over France.

6.1.2 Monitoring of foodstuffs by DGCCRF

The DGCCRF's radiological monitoring plan does not envisage any monitoring around the La Hague site in 2018. Accordingly, no fruit and vegetable samples will be taken. An annual 4 kg sample of 'leaf vegetables' (salad vegetables) is taken in the vicinity of the nuclear power plant at Flamanville and at Paluel, Penly and Gravelines. The purpose of the measurements is to determine the activity levels of free and bound tritium, ^{14}C and gamma emitters.

The DGCCRF also takes and analyses 'departmental' samples at inside and outside the influence of nuclear installations. A leaf vegetable sample is thus taken each year in each department of metropolitan France (except for departments 75, 92, 93 and 94), and consequently in Manche, Calvados, Orne and Seine-Maritime.

All samples are taken by the DGCCRF, which analyses some of them and sends others to the IRSN. The Joint Laboratory Service (SCL), a joint entity of the DGCCRF and the customs service, carries out the DGCCRF's analyses. These are mainly gamma spectrometry analyses for ^{137}Cs. However, these checks can include additional radionuclides. At the IRSN, the analyses are carried out in-house by the environmental analysis and metrology service (PSE-ENV/SAME) at the Vésinet site. These measurements can include gamma spectrometry, tritium and ^{14}C, as well as strontium, uranium, plutonium or americium analysis depending on the sampling point.

6.2 MONITORING BY THE OPERATOR

Orano carries out food chain monitoring by tracking a large number of bio-indicators.

6.2.1 Milk

The locations and identifiers of the Orano sampling points of milk are presented in Fig. 8 and in the table below. The measurement results are entered in the relevant register and sent to the RNM website.

Figure 8. Location of the milk sampling points

Identifier	Quantity	Location	Sampling	Measured in each sample
L1	5 litres	Hameau de l'Eglise (Herqueville)	Monthly	Tritium Carbon-14 Strontium-90 Potassium Gamma spectrometry[6]
L2	5 litres	Rue de Beaumont (Beaumont Hague)		
L3	5 litres	Hameau Ricard (Jobourg)		
L4	5 litres	Rantot farm (Digulleville)		
L5	5 litres	Hameau es Galle (Beaumont Hague)		

6.2.2 **Agricultural products**

The samples taken vary according to local dietary habits. The products are bought from local producers. The list below may be changed as a result of random events linked to annual output. The measurements listed in the table below are entered in the relevant register and sent by Orano to the RNM website.

Type	Quantity	Location	Sampling	Measured in each sample
Carrots (*)	8 kg	La Hague area, preferably downwind of prevailing winds	Annual	Bound tritium Carbon-14 (*) Free tritium Gamma spectrometry[7]
Cabbages (*)	7 kg			
Parsley	2 kg			
Leeks	4 kg			
Mushrooms	7 kg			
Blackberries	6 kg			
Herbs (*)	1 kg			
Potatoes[8]	5 kg			
Sheep meat	3.5 kg	La Hague area, preferably downwind of prevailing winds	Annual	Bound tritium *Free tritium Carbon-14 Gamma spectrometry
Poultry (*)	5 kg			
Rabbit	2 kg			
Eggs	36	La Hague area, preferably downwind of prevailing winds	Annual	Bound tritium *Free tritium Carbon-14 Gamma spectrometry
Honey	2 kg			
Cider[9]	5 kg			

[6] Beta/gamma emitters by direct measurement, in particular ^{137}Cs. Specific measurement of ^{129}I by radiochemical analysis.

[7] Beta/gamma emitters by direct measurement, in particular ^{137}Cs, ^{129}I and ^{241}Am.

[8] Supplementary deferred measurements: ^{90}Sr, isotopes of Pu, and ^{244}Cr

[9] Except ^{14}C and bound tritium

6.2.3 **Limpets**

A 6 kg sample of limpets is taken each quarter from each of the points presented in Fig. 9. The measurement results are entered in the relevant register and sent by Orano to the RNM website.

Figure 9. Location of low-water sampling points

Legend	
Prélèvements de basse mer	*Low-water samples*

6.2.4 Marine fauna

Quarterly samples of species of marine fauna are taken in three areas in the vicinity of the eastern, northern and western coasts from products bought from local fishermen/distributors (Fig. 10). The following radionuclides are measured for each sample:

- beta/gamma emitters by direct gamma spectrometry (in particular ^{60}Co, ^{106}Ru/^{106}Rh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am);
- ^{14}C;
- plutonium and other alpha emitters by alpha spectrometry.

The species chosen for analysis and the area in which they are sampled are as follows:

East coast (FM1)	North coast (FM2)	West coast (FM3)
Flat fish (7 kg) Round fish (5 kg) Oysters (30 kg) or Mussels (20 kg)	Flat fish (7 kg) Round fish (5 kg) Crabs (10 kg) Scallops* (15 kg)	Flat fish* (7 kg) Round fish* (5 kg) Crabs* (10 kg) Oysters* (30 kg) or Mussels* (20 kg) Lobsters (7 kg)

(*) one measurement of free and bound tritium is carried out annually.

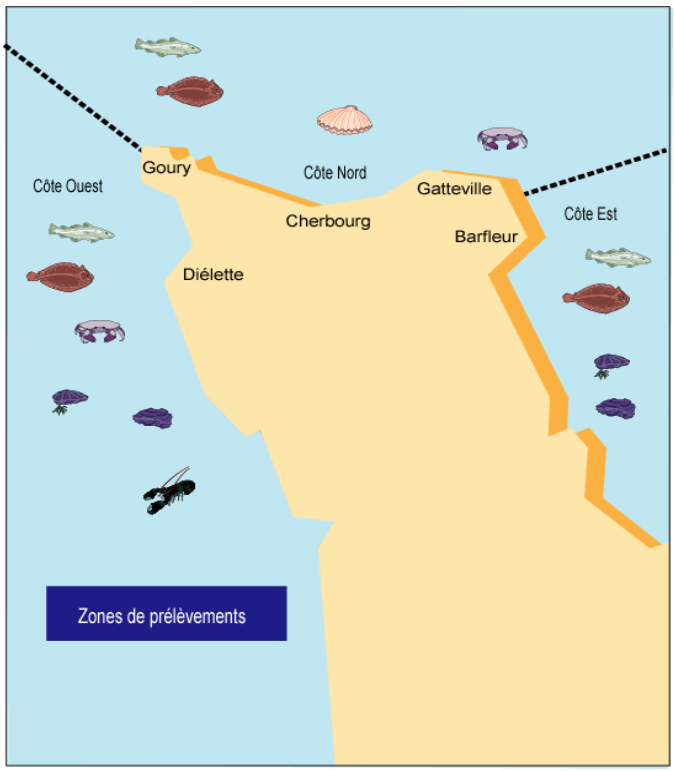

Figure 10. Samples taken by marine area

Legend	
Côte Ouest	*West coast*
Côte Nord	*North coast*
Côte Est	*East coast*
Zones de prélèvements	*Sampling areas*

7 MONITORING OF RADIOACTIVITY IN DRINKING WATER

7.1 MONITORING BY THE PUBLIC AUTHORITIES

7.1.1 National monitoring

The radiological quality of tap water is monitored by Regional Health Agencies (ARS) at points where water is entering the distribution network, mostly when exiting a drinking water production plant. It is analysed for the following parameters:

- gross alpha activity;
- residual gross beta activity;
- tritium;
- the indicative dose, i.e. the committed effective dose for one year of ingestion resulting from all natural and artificial radionuclides detected in water intended for human consumption, excluding tritium, K-40, Rn and its short-lived decay products (^{218}At, ^{214}Bi, ^{214}Pb, ^{214}Po, ^{218}Po, ^{210}Tl);
- Rn in groundwater intended for human consumption.

The values for gross alpha activity, residual gross beta activity, tritium and radon come directly from laboratory analyses of the water samples taken. The indicative dose is assumed to be less than or equal to 0.1 mSv/year when the first three indicators are below the guidance values. If one of these values is exceeded, the indicative dose is calculated through analyses of natural radionuclides (^{226}Ra, ^{228}Ra, ^{234}U, ^{238}U, ^{210}Po and ^{210}Pb) and/or artificial radionuclides (^{14}C, ^{90}Sr, ^{60}Co, ^{131}I, ^{134}Cs, ^{137}Cs, ^{238}Pu, ^{239}Pu and ^{241}Am).

The methods for measuring radionuclides and the indicators for the radiological quality of water are in line with the limits of detection laid down in the Directive 2013/51/Euratom, which was transposed in the Order of 19 October 2017 on the analysis methods used in the quality monitoring of water.

The frequency of analyses is set in orders issued by the Ministry of Health:

- gross alpha activity, residual gross beta activity, tritium: Order of 11 January 2007, as amended, on the sampling and analysis programme for quality monitoring purposes for water supplied by distribution networks, adopted pursuant to Articles R. 1321-10, R. 1321-15 and R. 1321-16 of the Public Health Code;
- radon: Order of 9 December 2015 laying down the procedures for measuring radon in water intended for human consumption.

The frequency of analyses depends on the volume of water distributed by the treatment and production plants and the number of people supplied by the distribution network. For gross alpha activity, residual gross beta activity and tritium, the frequency with which water samples are taken and analysed may be reduced when values are observed to be stable over a significant period of time. If the water abstraction point is near to an artificial or natural radiation source, which may change the radiological quality of the raw water or if remedial measures have been put in place to reduce the concentration of radionuclides, the frequency may not be reduced.

For radon, the sampling and monitoring frequency may be reduced, if radon is not likely to be present in the water at concentrations potentially exceeding the reference value of 100 Bq/l (based on past findings or the hydrogeological context).

7.1.2 Local monitoring in the vicinity of the La Hague site

The production and distribution of tap water in Manche is based on the operation of:

- 267 abstraction points, mainly for groundwater;
- 107 drinking water production plants;
- 162 distribution networks supplying the population with water.

Water samples to monitor the radiological quality of water are taken at points where water is entering the distribution network (monitoring points). This makes it possible to monitor the water distributed to all the municipalities supplied by the production plant. That is why the number of monitoring points is far lower than the number of municipalities (496 as at 1 January 2018).

The radiological quality of the water distributed was monitored by taking 144 water samples in 2016 and 154 water samples in 2017 to measure the gross alpha activity, the residual gross beta activity, the tritium content and the indicative dose. When the guidance values for gross alpha activity or residual gross beta activity are exceeded, natural radionuclides are systematically analysed.

Over the last two years, samples were taken at 106 monitoring points (Fig. 11) located at the drinking water production plants. In 2016-2017 gross alpha activity 0.1 Bq/l was exceeded in 12 water samples (4 % of the samples taken); the radioactivity measured was exclusively of natural origin and the analyses of the natural radionuclides showed that the indicative dose was less than 0.1 mSv/year for these samples. The guidance value for residual gross beta activity and the quality reference for tritium were not exceeded in any water sample analysed.

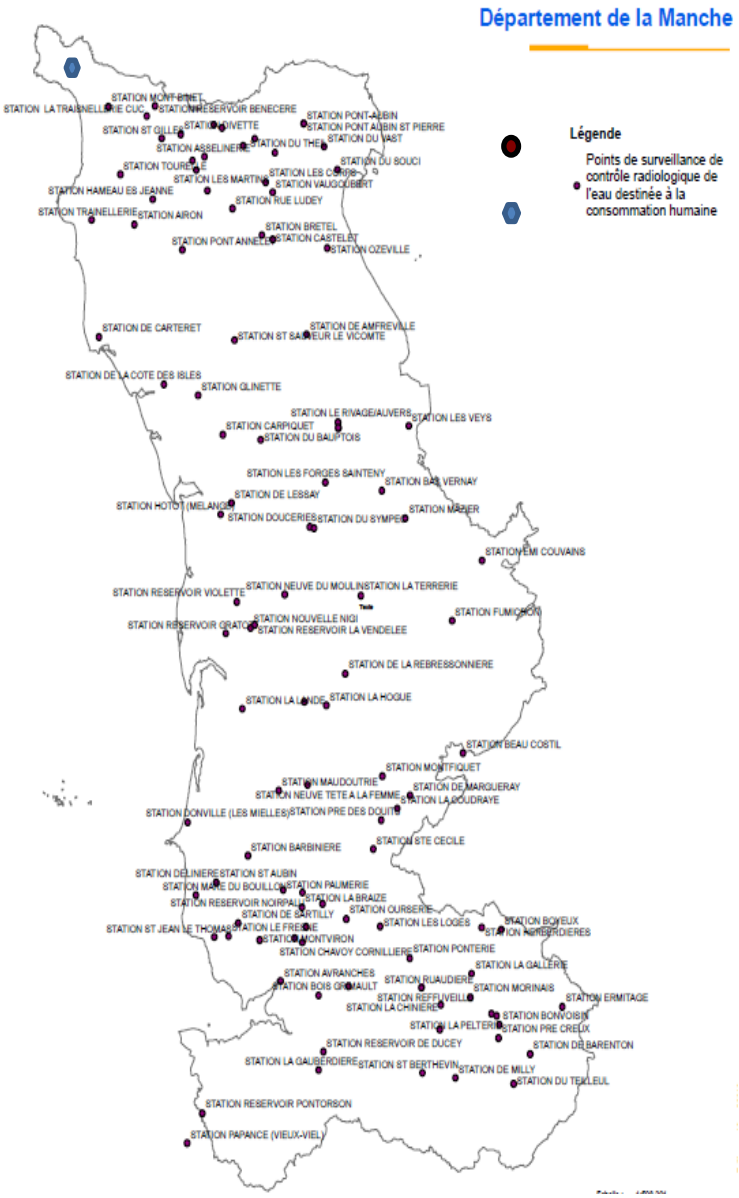

Figure 11. Drinking water monitoring points in Manche

7.2 MONITORING BY THE OPERATOR

In the vicinity of the La Hague site samples of drinking water distributed locally are taken at 3 plants and 10 boreholes. The locations of these sampling points are shown on Fig. 12. The samples are taken while the facilities are in operation, in the presence of an engineer from the water service of the La Hague federation of municipalities. The measurements listed in the table below are entered in the relevant register and sent to the RNM website.

Drinking water sampling point identifiers

Identifier	Quantity	Location	Sampling	Analysis
Rb1	1 litre	Beaumont water tower	Monthly	Alpha measurement Beta measurement ^{40}K ^{3}H
Mont-Binet	1 litre	Mont Binet plant		
Ste Croix	1 litre	Sainte Croix plant		
For01	1 litre	Vinnebus (Vauville) borehole	Quarterly	
For05	1 litre	Les 5 Chemins borehole		
For06	1 litre	Les Hougues borehole		
For11	1 litre	Hameau Fabien borehole		
For12	1 litre	Bacchus borehole		
For14	1 litre	Ste Croix Hague borehole		
For17	1 litre	Carrefour du Maupas borehole		
For18	1 litre	Le Houguet borehole		
For21	1 litre	Croix aux Dames borehole		

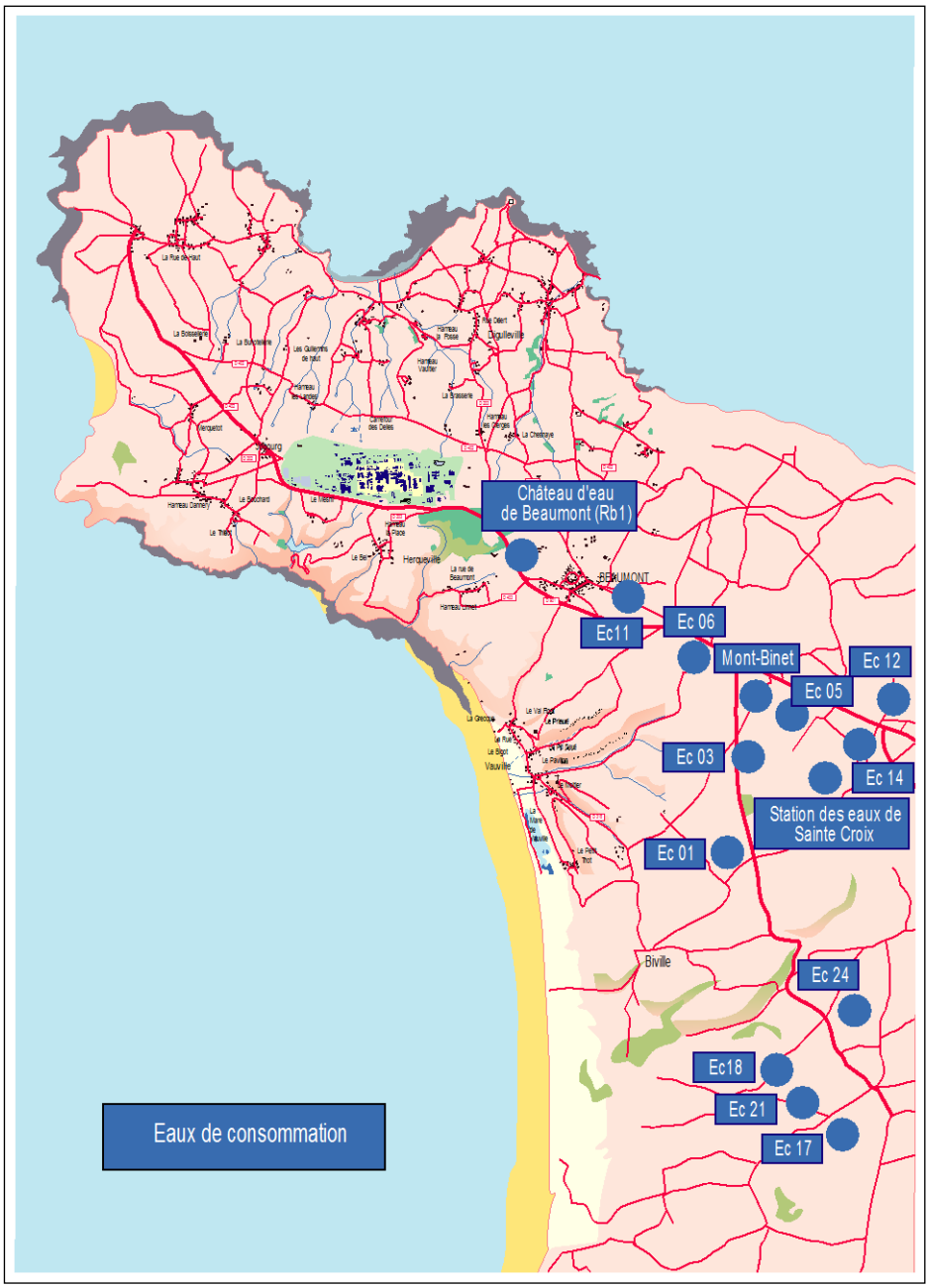

Figure 12. Map showing the water plants, water towers and Orano boreholes

Legend	
Eaux de consommation	*Drinking water*
Château d'eau	*Water tower*
Station des eaux	*Water plant*

8 PARTICIPATING LABORATORIES

8.1 LABORATORIES APPROVED TO MEASURE ENVIRONMENTAL RADIOACTIVITY

Approvals for laboratories to measure environmental radioactivity are issued by decision of the ASN pursuant to decision No 2008-DC-0099 of 29 April 2008, as amended by ASN decision No 2015-DC-0500 on the organisation of the National Network of Environmental Radioactivity Measurements. They lay down the procedures for approving laboratories. The list of laboratories approved to carry out the environmental radioactivity measurements referred to in Articles R. 1333-11 (R. 1333-25 from 1 July 2018) and R. 1333-11-1 (R. 1333-26 from 1 July 2018) of the Public Health Code is available on the ASN website[10].

8.2 LABORATORIES APPROVED TO MONITOR FOODSTUFFS

The laboratories approved by the DGAL to monitor foodstuffs as of 5 December 2017 are listed in the table below.

LDA 13	Bouches du Rhône	Laboratoire départemental d'analyses Technopôle de Château-Gombert 29 rue Frédéric Joliot-Curie 13013 MARSEILLE
LDA 19	Corrèze	QUALYSE site de Tulle Le Treuil - BP 202 19012 TULLE Cedex
LDA 31	Haute-Garonne	Laboratoire départemental Eau - Vétérinaire - Air 76, chemin Boudou CS 50013 31140 LAUNAGUET
LDA 44	Loire Atlantique	INOVALYS Nantes La Chantrerie Route de Gâchet - BP 52703 44327 NANTES cedex 3
LDA 50	Manche	LABEO Manche 1352 avenue de Paris CS 33608 50008 SAINT LÔ Cedex
LDA 53	Mayenne	Laboratoire vétérinaire départemental 224, rue du Bas des Bois BP 1427 53014 LAVAL Cedex
LDA 68	Haut Rhin	Laboratoire vétérinaire départemental 4, allée de Herrlisheim - BP 20351 68006 COLMAR Cedex
LDA 82	Tarn et Garonne	Laboratoire vétérinaire départemental 60, av Marcel Unal 82000 MONTAUBAN

The State laboratories of the Joint Laboratory Service (SCL), a joint entity of the DGCCRF and the customs service competent to monitor foodstuffs[11], are listed below:

Laboratoire de Lille	**Laboratoire de Marseille**	**Laboratoire de Bordeaux**	**Laboratoire de Strasbourg**
Domaine du CERTIA 369, rue Jules Guesde B.P. 20039 59651 Villeneuve d'Ascq	146, traverse Charles Susini 13388 Marseille	3 avenue du Dr Schweitzer CS98080 33600 Pessac	13, chemin du Routoir 67400 Illkirch-Graffenstaden

[10] https://www.asn.fr/Reglementer/Bulletin-officiel-de-l-ASN/Laboratoires-organismes-agrees-et-mesures-de-la-radioactivite/Listes-agrements-d-organismes

[11] As previously stated in § 6.1.2, the DGCCRF's radiological monitoring plan does not envisage any monitoring around the La Hague site in 2018; those laboratories are therefore not solicited for this purpose.

8.3 LABORATORIES APPROVED TO MONITOR DRINKING WATER

The laboratories approved by the Ministry of Health to carry out sampling and radiological analyses of water intended for human consumption as part of the quality monitoring of water are:

- Eichrom (Bruz, department 35)
- Subatech (Nantes, department 44)
- Labéo Manche (Saint Lô, department 50)
- Laboratoire Eurofins Expertises Environnementales - Maxéville site (Maxéville, department 54)
- Laboratoire des Pyrénées et des Landes (Tarbes, department 65)
- CARSO - Laboratoire Santé Environnement Hygiène (Vénissieux, department 69)
- Lyon Nuclear Physics Institute (Villeurbanne, department 69)
- SGS Multilab - Rouen site (Saint Etienne du Rouvray, department 76)
- IRSN/PRP-ENV/STEME Institute for Radiation Protection and Nuclear Safety (Le Vésinet, department 78)
- Tarn-et-Garonne Departmental Veterinary Laboratory (Montauban, department 82)
- Pearl (Limoges, department 87)
- Eurofins Hydrologie France - Les Ulis site (Les Ulis, department 91)

The analyses of the radiological quality of water intended for human consumption distributed in the Manche department are carried out, as part of quality monitoring, by Labéo Manche and the laboratory of the Institute for Radiation Protection and Nuclear Safety (Le Vésinet).

The list of laboratories approved to take samples and carry out analyses as part of the quality monitoring of water is available on the website of the Ministry of Health[12].

8.4 ORANO LA HAGUE LABORATORIES

Orano laboratories are part of the Radiation Protection Evaluation section within the Security, Safety, Environment and Protection directorate. They cover the following three work areas:

- Laboratories work area, which is responsible for carrying out radiological analyses on discharges and bio-indicators;
- Dosimetry work area, with responsibilities including passive dosimetry in the environment;
- Environmental Monitoring work area, which is responsible for taking samples in the environment, monitoring discharges, issuing the statutory registers to be sent to ASN and sending environmental data to the RNM.

The Laboratories work area comprises laboratories dealing with different radioactivity levels:

- Low-Level Radioactivity Laboratory (an environmental laboratory pursuant to the Order of 5 December 2016 ratifying ASN Decision No 2016-DC-0569);
- Intermediate-Level Radioactivity Laboratory (an effluent laboratory pursuant to the Order of 5 December 2016 ratifying ASN Decision No 2016-DC-0569).

The Laboratories work area carries out all the tasks necessary for the analysis and characterisation of samples as part of monitoring and radiological control programmes for persons and installations at the site and in its environment. It does not take samples. Only the Low-Level Radioactivity Laboratory is involved in monitoring radioactivity in foodstuffs and drinking water.

[12] http://social-sante.gouv.fr/sante-et-environnement/eaux/article/laboratoires-agrees-pour-le-controle-sanitaire-des-eaux

The Dosimetry work area comprises three main tasks to carry out dosimetry work:

- Individual Dosimetry, the main task of which is to prepare, perform and manage individual dosimetry, site area dosimetry and environmental dosimetry and to disseminate the results;
- Metrology, whose main tasks include traceability of the photon and neutron radiation fields for the Dosimetry work area; manufacturing the working standards needed for dosimetry work and calibrating radiation protection instruments;
- Maintenance of metrological references by carrying out the calibrations required by regulations and standards and participating in inter-comparison programmes; reading dosimeters; giving expert opinions and expressing results.

The Environmental Monitoring work area has the following tasks:

- taking all samples in the environment;
- tracking the radiological measurements (continuous and deferred measurements) by the various devices monitoring the environment and discharges;
- validating the data on discharges into the sea in accordance with the environmental monitoring programme;
- drawing up all the statutory and in-house reports concerning radioactive discharges from Orano Cycle's La Hague site and monitoring of its environment.

The work area does not carry out analyses, as these are the responsibility of the Laboratories and Dosimetry work areas.

8.4.1 **Sample management**

The Environmental Monitoring work area (DSSEP/RE/E) takes the samples and carries out some of the preparatory steps. No tests or analyses are outsourced. Each sample taken under the monitoring programme is recorded in the computer (GRAAL application). It generates an analysis request, which is included automatically in the laboratory information management system.

There is an incoming sample log at laboratories' drop-off points to record the samples. Conditions of acceptance specify, for each laboratory and type of sample, the criteria to follow so as to ensure that a sample given for analysis can be accepted by the laboratory. When a sample cannot be accepted (non-compliance with acceptance criterion or sample not present), the analysis request is rejected in GRAAL. Electronic receipt in GRAAL means that the sample is accepted by the laboratory. Receipt of a sample is confirmed by the persons taking delivery of the sample after verifying that:

- it complies with the acceptance conditions;
- its EXPR number and sampling date correlate;
- the analyses requested are feasible.

Processing of samples starts when the following conditions are met:

- an analysis request has been created;
- the corresponding sample has been dropped off at the laboratory;
- the sample has been registered;
- the information provided concerning the sample and the analyses to be carried out is sufficiently complete;
- the quantity of the sample provided and the way it is packed are compatible with the analysis requested;
- the acceptance criteria in place have been followed.

If for any reason it is impossible to process a sample, the laboratory returns it to the sender.

8.4.2 **Traceability during analysis**

When a sample is received, a set of bar code labels linked to the analyses requested is printed. An additional set of labels can be printed at any time. These labels feature the number of the analysis request and are fixed on the various sample containers used for the analytical tests and on certain laboratory logbooks.

Throughout the analysis, an analysis request number identifies process samples. In order to ensure that the analysed results are traceable, staff members stamp the print-outs when they are being archived in paper format. All Excel spreadsheets of results are stamped and archived.

8.4.3 **Validation**

A staff member performs an initial validation of the analysis results. This validation primarily covers conformity with the criteria laid down for the type of apparatus or analysis concerned, thus allowing the measurements to be validated (calibration, background noise, controls for the series, sufficient yield, etc.).

At the second validation stage, the operator makes sure that the measurements taken are consistent, so as to finalise the result. If a problem is identified, the staff member may repeat an analysis as many times as is needed. Unless specifically indicated in the relevant operating protocol, the last measurements carried out are to be validated once the consistency of the measurements is confirmed.

The line manager may set activity ranges based on the history of the samples or regulatory provisions. The staff member therefore does not have to validate their results electronically when they are within the expected ranges.

The technical manager does the final validation of all the results of analysis requests, whether they are disseminated or not. This validation covers the entire process followed, staff competence, equipment, performance times, and the reliability and consistency of the results. It triggers the sending of the results to the client.

8.4.4 **Reporting of results**

Analysis results are sent within EXPR to in-house clients. To external clients a hard-copy analysis reports is sent. Unless otherwise requested, only artificial radionuclides are measured and reported. For the Intermediate-Level Radioactivity Laboratory, the activity values reported have a reference date on the measurement date, whilst for the Low-Level Radioactivity Laboratory the sampling time is used as reference time.

The activity values reported for ^{106}Ru/^{106}Rh and ^{144}Ce/^{144}Pr correspond to the cumulative activity values of the two radionuclides in equilibrium. The activity values reported for ^{137}Cs correspond to the activity of that radionuclide alone, even if the measurement involves measuring the de-excitation gamma radiation from ^{137m}Ba. For ^{90}Sr the activity value reported corresponds to ^{90}Sr alone, not to the ^{90}Sr/^{99}Y pair.

The table below presents the retention periods applied to analysis documentation. If analysis data are backed up electronically in GRAAL, retention on paper is not necessary. For applications in operation, incremental and full backups ensure that data are retained in the database.

Retention periods of monitoring results

Type		Retention period
Analyses for environmental reports and external clients	Liquid effluents	5 years
	Gaseous effluents	5 years
	Samples for environmental monitoring	5 years
	Samples provided by external clients	5 years
Calibration and verification documents	Calibration findings	apparatus lifetime + 5 years
	Verification findings	apparatus lifetime + 5 years
	Raw verification and calibration data	apparatus lifetime + 5 years

8.4.5 Sample storage

After analysis, water samples processed at the laboratory are stored in plastic bottles, following the recommendations given in standard NF EN ISO 5667-3. The techniques for storing liquid samples are as follows:

- acidification to pH <1 by adding 5 ml of concentrated HNO_3;
- storage in the dark at between 1 and 5 °C in hermetically sealed geometries.

Solid samples are stored in their packaging. After analysis, fresh samples are destroyed or returned to the client depending on the request. Storage periods are laid down for each type of sample. Samples are destroyed after the date predetermined at the Laboratories work area.

8.4.6 Laboratory equipment

The table below presents the Orano Cycle La Hague laboratory analysis equipment.

Orano laboratory analysis equipment

Type of apparatus	Make	Model	Identifier 1480/7128/
Gamma, x-ray spectrometry	CANBERRA	GC 3518	CPS/36B
	CANBERRA	GC 3519	CPS/35B
	CANBERRA	GL2015R	CPS/X2
	CANBERRA	BE5030	CPS/XG1
	CANBERRA	BE5030	CPS/XG2
***α* spectrometry**	EURISIS M.	IPC 300-100-16	CPS/77
	EURISIS M.	IPC 300-100-16	CPS/78
	CANBERRA	300-19-100-AM	CPS/79
	CANBERRA	300-19-100-AM	CPS/80
	CANBERRA	300-19-100-AM	CPS/81
	CANBERRA	300-19-100-AM	CPS/82
	CANBERRA	300-17-AM	CPS/83
	CANBERRA	300-19-100-AM	CPS/84

Type of apparatus	Make	Model	Identifier 1480/7128/
Liquid scintillation counting	PACKARD	3170	ANA/12
	PACKARD	3170	ANA/14
	PACKARD	2900	ANA/15
	PACKARD	2900	ANA/17
α β counting	TENNELEC	LB5500	ECH/188
	TENNELEC	LB5500	ECH/222
	TENNELEC	LB5500	ECH/244
	TENNELEC	LB5500	ECH/909
	BERTHOLD	LB790	ECH/790

Calibration and verification procedures are determined and applied to measurement apparatus and ancillary equipment in line with their use in the analysis to ensure that the calibration uncertainty is in line with the overall uncertainty of each method. The procedures are described in the operating protocols available in the document management system. The frequency of verifications and calibrations is indicated in the corresponding operating protocols.

Each piece of apparatus requiring calibration is marked with the last and next calibration dates (month/year). This is done using either control sheets or special stickers.

Within a category of apparatus requiring calibration, some items do not require metrological monitoring in view of the specific way they are used (e.g. pipettes used for test samples measured by weight). Such items are thus marked with special stickers.

A piece of equipment is verified or calibrated by decision of the technical manager or the metrology manager whenever an activity (e.g. maintenance) may have caused doubt on its integrity.

Verifications carried out periodically on the measurement equipment make it possible to ensure that they have not deviated and that they are in line with the calibration criteria that have been set. If one of the criteria verified is out of the set calibration criteria, action must be taken to ascertain whether it has had an impact on the results reported. If so, a correction will be sent to the client and an error ticket will be opened. If no impact on the analysis results is demonstrated, no error ticket is opened.

There is a file for each type of apparatus containing the following documents:

- the apparatus inventory sheet;
- the preventive and corrective maintenance sheet (for equipment requiring maintenance);
- the sheet setting the criteria for calibration, verification and use;
- the sheets for monitoring the calibration and verification of the apparatus as per the associated operational protocols.

Maintenance of the equipment is carried out in line with the site procedures. The Maintenance section and the Information System section have, in agreement with the Laboratory, drawn up a strategy and frequency for the preventive maintenance.

8.4.7 Accreditations and participation in inter-laboratory comparison exercises

The Low-Level Radioactivity Laboratory is accredited by COFRAC (French Accreditation Committee) for ‘laboratory analysis of nuclides in all types of environmental samples, LAB REF 35’. Details of the tests covered by this accreditation are presented in Technical Annex No 1 to Accreditation 1-1524,

available on COFRAC's website[13]. For clients, the list of analyses carried out under the COFRAC accreditation is detailed in the annual contract review.

The laboratory is approved by the ASN for the environmental radioactivity measurements listed in the table below. Such approvals are issued after a national committee has given its positive opinion and the laboratory has acceptable results of the inter-laboratory tests organised by the IRSN.

Within its area of activity, the laboratory participates in other various inter-laboratory tests with the following bodies:

- Henri Becquerel National Laboratory (LNHB);
- International Atomic Energy Agency (IAEA);
- Committee for Establishing Analysis Methods (CETAMA);
- General Association of Environmental Analysis Laboratories (AGLAE).

Laboratory staff using the measurement apparatus and routine operating equipment carry out these tests. The laboratory also participates in information sharing with other laboratories, which are carrying out analyses in the same technical field through its participation in various working groups of the Nuclear Equipment Standardisation Office (BNEN) and of CETAMA.

Measurements authorised by the ASN

Code	Measurement	**Type 1 Water** Drinking water Surface water Groundwater Waste water	**Type 2 Earth matrices** Soil Sediment Mud	**Type 3 Biological matrices** Fruit and vegetables Milk Fauna Flora	**Type 4 Aerosols on filters**	**Type 5 Gas/air**	**Type 6 Surrounding environment**
..._01	Gamma > 100 keV	x	x	x	x	x	
..._02	Gamma < 100 keV	x	x	x		x	
..._03	Gross alpha	x			x		
..._04	Gross beta	x			x		
..._05	Tritium	x		x		x	
..._06	Carbon-14			x		x	
..._07	Strontium/Yttrium-90	x	x	x			
..._08	Other pure beta						
..._09	Isotopes of U						
..._10	Isotopes of Th						
..._11	Radium-226 + daughters						
..._12	Radium-228 + daughters						
..._13	Isotopes of Pu, Am, etc.	x	x	x	x		
..._14	Halogenated gases					x	
..._15	Noble gases						
..._16	Gamma dosimetry						
..._17	Total uranium						

Measurements not within the remit of the Laboratories work area

[13] www.cofrac.fr

9 OPERATORS MOBILE MONITORING SYSTEMS

9.1 MOBILE SAMPLING SYSTEMS

The Orano La Hague site has mobile equipment for monitoring of discharges and the environment, whether on a routine basis or in specific circumstances. Four autonomous trailers (Fig. 13) are available, equipped with the following sampling and measurement equipment:

- system for sampling aerosols with continuous alpha/beta measurement;
- probe for continuous measurement of the ambient gamma dose rate;
- system for sampling iodine and aerosols;
- mobile sampling equipment allowing samples of bio-indicators (grass, soil, water, etc.).

Measurement data and a report confirming the correct operation of the equipment are sent in real time to the Environment Command unit. Each trailer has an electrical generator and a lighting system. They can be powered also from an external power source. They can be deployed at anytime, anywhere in the environment. Two 4x4 vehicles are available for moving the trailers.

Figure 13. La Hague site emergency monitoring trailer

9.2 MOBILE ANALYSIS SYSTEMS

The La Hague site has a laboratory vehicle (Fig. 14 and 15), which is available at all times and can be brought to a suitable location. This vehicle has the following analysis equipment:

- gamma spectrometry system with NaI detector;
- alpha/beta counter for aerosol filters and 50 mm planchets;
- alpha spectrometry system;
- evaporator;
- equipment and sundries needed to prepare the samples;
- portable measurement equipment (contamination meter, spectrometer, etc.).

The equipment can be powered by three independent sources: an electrical generator, a connection to an external power source or the vehicle's battery.

Figure 14. La Hague site mobile monitoring laboratory

Figure 15. Mobile monitoring laboratory interior

10 VERIFICATIONS

10.1 GENERAL

The verification team was informed about the La Hague site routine and emergency environmental radioactivity and drinking water monitoring arrangements before starting the verifications. The verifications were carried out according to the agreed programme (Annex 1).

10.2 ORANO LA HAGUE SITE

10.2.1 Low-activity (environment) laboratory

The Orano low-activity laboratory, which analyses the samples from the environment, was verified. The laboratory has 10 staff members. It has accreditation (1-1524 Cofrac) and is very well equipped for management and analysis of environmental samples. Sample management is done by the laboratory LIMS system, which generates barcodes for the samples. The analysis equipment includes the following:

- total alpha/beta counters (4)
- gamma spectroscopy systems (5)
- alpha spectroscopy system
- beta counters.

The low-activity laboratory is approved by the ASN for environmental measurements. It participates in inter-comparison exercises organised by the IRSN and the IAEA.

> *No remarks. Verification team commends the practise of using a separate X-ray detector measurement for correcting the biological sample self-absorption in the gamma counting.*

10.2.2 Medium-activity (discharge) laboratory

The Orano medium-activity laboratory, which analyses the plant discharge samples was verified. Authorisation from the laboratory is required before any site liquid discharge tanks can be released to the sea. Typically, there are about 500 tank discharges each year.

Additional analyses carried out on the sea releases are Tri-Butyl-Phosphate by High Performance Liquid Chromatography (HPLC9 and NO_3 and NO by ionic chromatography. These analyses are not integrated in the LIMS system. They are done after the release is done as they require longer than the 4 h analysis time.

The liquid release samples of one month are combined in a monthly composite sample. This sample is analysed and the results are crosschecked against the individual tank sample results. All samples are kept till the results are validated. Air filters are kept for 2 months

The laboratory is physically separated from the low-activity laboratory, but works according to similar principles. The laboratory has no accreditation, but is very well equipped for management and analysis of discharge samples. Practices are in line with the organisational and technical requirements laid down by standard NF EN ISO/CEI 17025. Sample management is done by the laboratory LIMS system, which generates barcodes for the individual samples. The analysis equipment includes the following:

- total alpha/beta counters (4)
- gamma spectroscopy systems (4)
- liquid scintillation counters
- alpha spectroscopy systems
- beta-counters

The medium activity laboratory carries out an annual crosscheck of results with an independent laboratory (IRSN), but does not take part in other laboratory intercomparison activity.

As a matter of good laboratory practice, the verification team suggests that the medium-activity laboratory would search for additional intercomparison opportunities.

10.2.3 **Dosimetry laboratory**

The Orano dosimetry laboratory was verified. It is in charge of reading all TLDs, both for personnel and environmental dosimetry. The laboratory handles about 10 000 TLDs each month; only about 50 of them come from the environment monitoring programme. The laboratory main equipment are four Harshaw TLD readers.

No remarks.

10.2.4 **On-site monitoring equipment**

The verification team verified the monitoring systems located at the station 7 close to the site fence. Altogether, there are eight such stations at the site. At these stations radiation dose, dose rate and radioactivity in air is monitored. The stations are equipped with rainwater collection systems, which are emptied weekly and can be analysed in case of an event. The equipment is located in air-conditioned containers connected to the site secure electrical grid. Electrical power is locally secured for one hour. On site, three diesel generators of 9MW each are available in case of an emergency.

The radiation dose is monitored using a TLD. Altogether there are 11 such dosimeters on site.

The radiation dose rate is monitored using a dose rate probe. Readings and high-level alarms are provided to the Environment Command unit (alarm limit 200 nSv/h).

Radioactivity in air is monitored using an automatic aerosol monitor (alpha/beta/Radon). Readings and high-level alarms are provided to the Environment Command unit. An older system based on weekly exchanged paper filter analysis is also operational as a back up. Pressure difference over the filter is monitored to ensure its well-functioning.

No remarks.

10.2.5 **Monitoring of radioactivity in the site drainage water**

Site drainage water is collected in a large collection pond. The outflow from the pond is monitored using an on-line monitor (Fig. 16) and an automatic water sampling system (Fig. 17). The on-line beta/gamma monitor uses a gamma detector (NaI) and a beta gas flow proportional counter. Both detectors are looking at the same water flow through the sample tank. The alarm level is set at 3.7 Bq/l. The system is custom-built for La Hague.

The automatic water sampler samples 40 ml every 30 minutes, i.e. 2 litres per day. These 2L samples are analysed daily. The sampling frequency can be increased if there is an alarm from the on-line system. The system is refrigerated.

No remarks.

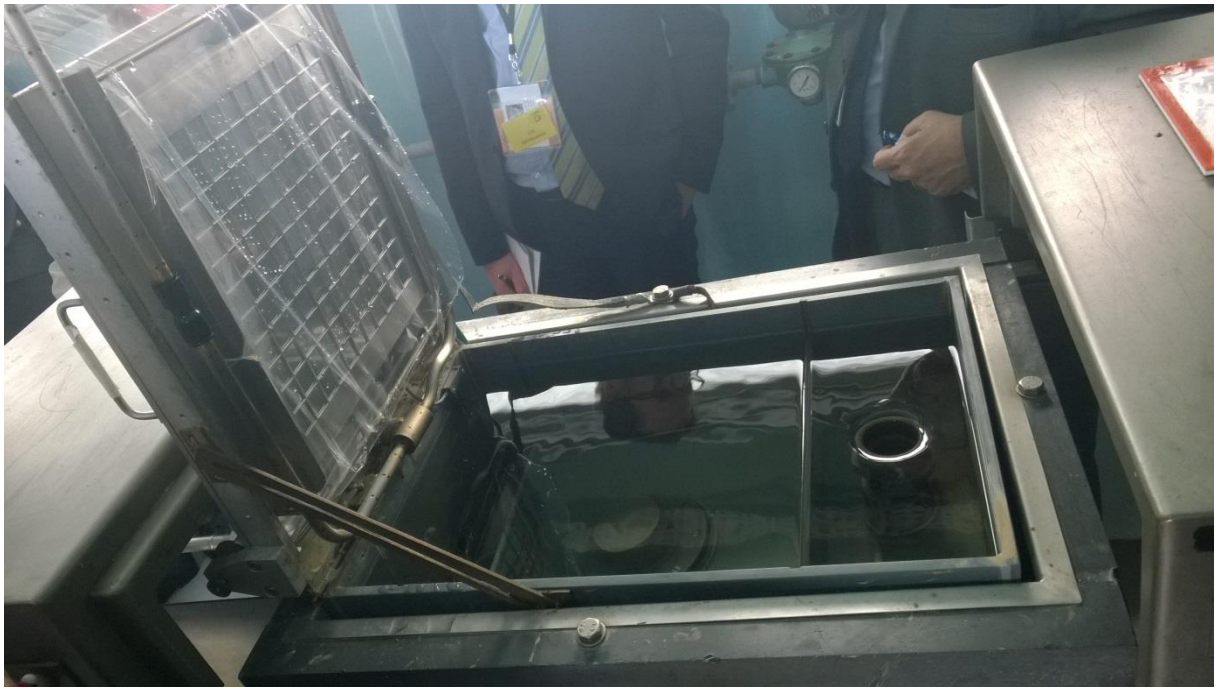

Figure 16. On-line drainage water monitor

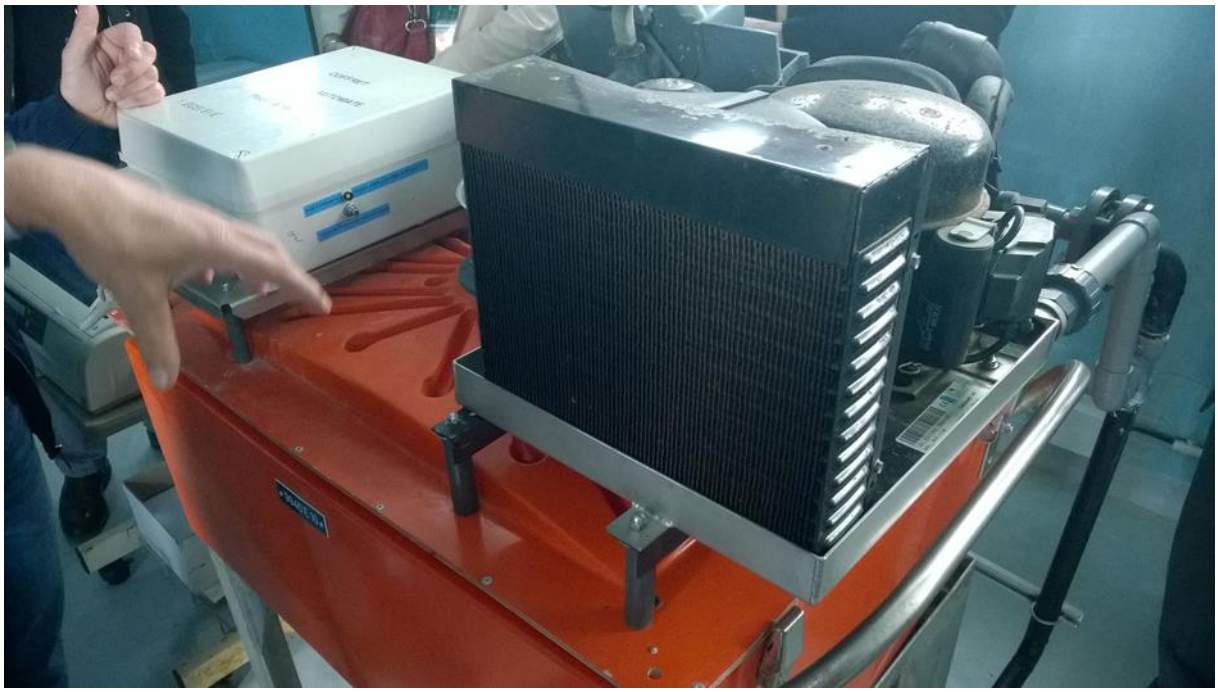

Figure 17. Refrigerated automatic drainage water sampling system

10.2.6 **Monitoring of ground water**

The verification team visited the location next to an old radioactive waste storage facility where small amounts of radioactivity have been detected in the ground water. The site is equipped with piezometers and pumps for ground water sampling. Water is daily sampled from the piezometers to detect potential leakage of radioactivity. Samples are analysed for ^{3}H daily (limit for ^{3}H < 30 Bq/l min 5 days per week and 50 Bq/L per week).

No remarks.

10.2.7 **Monitoring of gaseous discharges at silo 115**

The verification team visited the gaseous discharge monitoring facility installed to monitor the stack discharges from the 32 hot cells at silo 115. The system includes weekly filter and monthly active charcoal sampling.

The monitoring system airflow is measured and recorded. There is no total flow measurement at the stack, so in order to estimate the total discharge a nominal airflow is used.

No remarks.

10.2.8 **Off-site radioactivity monitoring station at Digulleville**

One of the Orano off-site radioactivity monitoring stations was verified. It is located at Digulleville, about 2 km from the site. There are five similar stations in the site surrounding area.

The station equipment includes the following:

- Gamma dose rate meter (same as in the fence stations);
- Alpha-beta aerosol measurement (collected every 24h, 7 m^3/h, alarm level 1 mBq/m^3). Filters are analysed daily and combined in a sample covering the whole month.
- Iodine filter (two charcoal cartridges, 7 day sample);
- ^{85}Kr monitor (two proportional counters, detection limit 100 Bq/m^3). The maximum average krypton release per month is 1850 Bq/m^3, which would result in a dose of 6 microsievert/year to the critical group. Total release of krypton from the site is about 300 000 TBq/year. Krypton is monitored at the release stack and in the village stations. Sometimes fuel cutting needs to be paused because the krypton activity concentration limit is exceeded. This needs to be reported to the ASN.
- Tritium monitor (MARC 7000 gas bubbler, exchanged every 7 days, limit 8 Bq/m^3);
- ^{14}C monitor (HAG 7000 gas bubbler, exchanged every 14 days, captured in a NaOH, limit 1 Bq/m^3)

Access to the station is limited to ORANO staff. All the systems have electrical backup (batteries and a diesel generator to be started up manually by the laboratory staff).

The equipment is located in a spacious building in the Digulleville village centre. The location of the gamma dose rate probe is not ideal, because the building and the surrounding trees shadow it.

No remarks.

10.2.9 **Monitoring of environmental contamination outside the site**

In response to the report by the IRSN in 2017[14], the verification team visited an area where small amounts of artificial radioactivity have been detected, likely due to a leak from an old waste storage facility located on site close to the fence. The contaminated area is located next to the plant fence where ground water emerges from ground and forms a small river (Fig. 18). The area is ORANO property, but located outside the site fence and accessible to the public. According to the IRSN report, ^{137}Cs, Pu, Am and ^{90}Sr have been detected in a small area. The contamination originates from old events of the 70's and 80's.

Orano is carrying out a surveillance programme of the area and reports the results to the ASN on a regular basis. In addition, the IRSN monitors the soil, water and sediments. The team was informed, that the levels of contamination in soil are below 70 Bq/kg, but are higher in the sediments. The activity level in grass is below the detection limit for ^{137}Cs.

[14] IRSN/2017-00136 of 20 April 2017, Présence de radioactivité artificielle au nord-ouest de l'établissement AREVA NC de La Hague

A complementary sampling plan in proximity outside the contaminated area is in place for ^{90}Sr and alpha emitters in water and ^{137}Cs in soil (sampling every three months).

The team was informed that a follow-up monitoring and remediation plan has been drafted by the operator and is currently being reviewed by the ASN.

The verification team recommends that ORANO continue the surveillance of the contaminated area in line with the report IRSN/2017-00136, in particular as regards a possible transfer of radionuclides to agricultural products via surface and ground water.

The team stresses the importance of maintaining full transparency towards the local community concerning the results of the surveillance and possible remediation measures.

Picture 18. Upstream view of the small river towards the contaminated area next to the La Hague site

10.2.10 Emergency monitoring

Monitoring trailers

Four Orano trailers equipped for environmental monitoring in the event of an accident were verified. These trailers can be placed in strategic locations for independent monitoring operation. They can measure radioactive aerosols, ^{14}C, alpha/beta activity in air, dose rate, rain (yes/no) and temperature. Air monitoring is based on a rolling filter paper with on-line detection. There is also an activated charcoal cartridge for off-line gaseous iodine monitoring. Altogether, some 20 staff members have been trained to use the trailers.

Trailers have a GPS-positioning system and a diesel generator for long-term independent operation. Monitoring data is sent to the site emergency centre via radio. Two 4x4 vehicles are available for moving the monitoring trailers to their designated locations in the event of an accident.

Mobile laboratory

Orano has one mobile laboratory, which is custom-built in a van. The vehicle is equipped with an alpha beta plastic scintillator, an alpha spectrometer and a gamma spectrometer (NaI). Some handheld equipment is also available. The van is equipped with a diesel generator for long-term independent operation. The laboratory can be operated by 2 persons. The equipment can be used by 10 environmental team and 10 shift workers. They are trained to use the equipment; regular training exercises take place.

No remarks.

10.3 IRSN

10.3.1 Radioactivity monitoring station at Omonville-la-Petite

The verification team visited the IRSN radiation monitoring station at Omonville-la-Petite, located about 5 km from the site. It serves for both routine monitoring and research purposes. The station equipment includes the following:

- ^{85}Kr monitors
- Aerosol samplers
- Iodine sampler
- Tritium sampler (zeolite trap developed by the IRSN)
- Meteorological monitors (wind, temperature, humidity)
- Plant radioactivity uptake research installations

The site serves primarily long-term environmental radioactivity research purposes, not continuous radiation monitoring, so it is not equipped with high-activity alarms or electrical back-up systems.

No remarks.

10.3.2 Cherbourg laboratory

The IRSN laboratory in Cherbourg was visited. This laboratory is very well equipped for both routine radioactivity surveillance and scientific research. The routine radioactivity surveillance laboratory is equipped for atmospheric, terrestrial and marine radioactivity monitoring. The main equipment is the following:

- Sample preparation equipment (freeze driers, ovens, etc.)
- Radiochemical laboratory equipment
- HPGe gamma spectroscopy systems (4)
- Portable HPGe gamma spectroscopy system (1)

- Liquid scintillation counter (TriCarb 2700TR)
- Alpha spectrometer (Canberra 7401)

IRSN Cherbourg laboratory research projects include for example the following:

- Tritium dispersion in the Bay of Biscay
- Radionuclide transfer in marine organisms
- Radionuclide dispersion and transfer in sediments
- Radionuclide atmospheric dispersion
- Dry deposition of aerosol particles
- Iodine dry deposition modelling
- Tritium transfer processes

In addition, the laboratory has developed many advanced techniques for both atmospheric and marine sampling and radioactivity monitoring.

No remarks.

11 CONCLUSIONS

All planned verification activities were completed successfully. The documentation supplied in advance of the visit, as well as the additional information received during and after the verification activities met a high quality standard and proved to be very useful.

The information provided and the verification findings gave rise to the following observations:

(1) The verification activities found that the facilities to carry out continuous monitoring of levels of radioactivity in the environment, drinking water and food in the vicinity of the La Hague site are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(2) The verification activities found that the facilities to carry out monitoring of levels of radioactivity in the environment in the event of an emergency at the Orano La Hague site are adequate. The Commission could verify the operation and availability of a representative part of these facilities.

(3) One recommendation and one technical suggestion are formulated. Notwithstanding these remarks, the verified parts of the monitoring system for environmental radioactivity and drinking water in place are in conformity with the provisions laid down under the Article 35 of the Euratom Treaty.

(4) The verification summary is set out in the 'Main Conclusions' document addressed to the French competent authority through the France Permanent Representative to the European Union.

(5) The Commission services kindly request that the French authorities submit, at the latest before the end of 2020, a report on the implementation of the recommendation concerning section 10.2.9 and on any significant changes in the set-up of the monitoring systems.

(6) In addition, the Commission services request that the French authorities provide, as soon as available, a copy of the remediation plan concerning the environmental contamination area discussed in section 10.2.9 and subsequent reports of its implementation.

(7) The verification team acknowledges the excellent cooperation it received from all persons involved in the activities undertaken during its visit.

ANNEX 1

VERIFICATION PROGRAMME

29 May 2018 - Site Orano Cycle La Hague

8h45 – 9h20	Présentation du cadre réglementaire des visites de vérification faites au titre de l'article 35 du traité Euratom – *Vesa Tanner (Commission européenne)*
9h20 – 9h30	Introduction et présentation des autorités françaises – *Eugénie Vial (CTE)*
9h30 - 10h00	Le réseau national de mesures de la radioactivité de l'environnement (RNM) – *Nathalie Reynal (ASN)* L'agrément des laboratoires –*Marc Fournier (ASN)*
10h15 – 10h30	Présentation générale du groupe Orano et du site de La Hague – *René Charbonnier* (Orano Cycle) + film
10h45 – 11h10	L'encadrement réglementaire des rejets liquides et gazeux du site de La Hague et de la surveillance de l'environnement - *Gabriel Plancque (ASN)*
11h10 – 11h40	Site Orano Cycle de La Hague : rejets et surveillance de l'environnement – *Loïc Cardin (Orano Cycle)*
11h40 – 12h00	La surveillance de l'environnement par l'IRSN – *Maxime Morin (IRSN)*
13h30 – 14h00	Déplacement sur le site de La Hague et formalités d'accès
14h00 – 17h30	Accueil au bâtiment 148 et remise en contexte des activités menées au sein du bâtiment Visite du laboratoire « environnement »

30 May 2018 - Site Orano Cycle de La Hague

9h30 – 12h30	Poursuite de la visite du bâtiment 148 : laboratoire de contrôle des effluents et laboratoire de dosimétrie
14h00 – 17h00	Tour du site (service communication Orano Cycle de La Hague) Station météo Véhicules d'intervention du laboratoire Station de mesures / prélèvements en pied de la cheminée UP2 800 1 station clôture Emissaire gazeux Em93 Réseau de piézomètres mis en service pour la surveillance du Silo 130

31 May 2018 – Environs du site de La Hague et Cherbourg

9h-10h	Site du ru des Landes Visite de la station de surveillance de l'environnement Orano Cycle du village de Digulleville
10h30 - 11h30	Visite de la station IRSN d'Omonville-la-Petite
13h30 – 16h30	Présentation des activités des activités du Laboratoire IRSN de radioécologie de Cherbourg-Octeville – *Denis Maro (IRSN)* Visite du laboratoire IRSN
16h30 – 17h00	Débriefing de la visite de vérification

ANNEX 2

PREPARATION AND ANALYSIS METHODS AT THE ORANO LABORATORIES IN LA HAGUE

MILK SAMPLES **Preparing the sample**			
Preparing the ashes: Calcine 2 litres of milk in a furnace at up to 600 °C. Preserving the milk: add bronopol.			
Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference and/or accreditation text**
Gamma spectrometry (qualitative and quantitative)	Package in SG 3000 geometry (3 litres).	Spectrometry on high-purity germanium detector.	NF EN ISO 10703. COFRAC (French Accreditation Committee) accreditation No 1-1524.
Strontium-90	Dissolve the ashes of 1 litre of milk. Add carrier (stable yttrium oxide). Liquid-liquid extraction of yttrium with TBP. Precipitate the yttrium oxalate. Recover and calcine the precipitate at 900 °C. Verify the absence of interfering beta radiation by monitoring the decay of yttrium-90.	Counting of the precipitate in a stainless steel dish on a counter with low background noise. Determination of the reaction yield by weighing the precipitate.	NF M 60-806-2 (partially). Report CEA-R-3653 (Dec. 80).
Free tritium	Freeze dry 50 ml of milk. Recover the water released.	Direct measurement by liquid scintillation. Results expressed in Bq per litre of water.	Standard NF EN ISO 9698. COFRAC Accreditation No 1-1524. Programme 135.
Iodine-129	Add a carrier of stable NaI to around 5 litres of milk. Place I^- ions on anionic resin. Elute IO_3^- then reduce to I_2. Liquid-liquid extraction of I_2 with chloroform. Re-extract iodine in an aqueous, alkaline, reducing medium.	X-ray spectrometry on a high-purity germanium detector in G5065 geometry. Determination of the reaction yield by ionometry.	No standard.
Carbon-14	Freeze dry 50 ml of milk. Prepare 0.5 g pellets. Calcine one pellet using an oxidiser. Recover CO_2 in a mixture of 8 ml of Carbosorb and 12 ml of PermaFluor.	Liquid scintillation counting.	NF M 60 812-2
Potassium	Dissolve milk ashes.	Flame emission spectrophotometry.	Standard NF T 90-019

SAMPLES OF AGRICULTURAL PRODUCE fruit, vegetables, meat and farm products			
Preparing the sample			
Separate inedible parts, wash tubers in water (to remove soil), cut up into small pieces, dry at 60 °C to a constant weight, grind mechanically, package the dry product in the geometry suited to the measurement.			
Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference and/or accreditation text**
Gamma spectrometry (qualitative and quantitative)		Direct spectrometry on high-purity germanium detector.	NF ISO 18589-3. COFRAC accreditation No 1-1524. Programme 135.
Iodine-129		Direct spectrometry on high-purity germanium detector with calculation of self-attenuation.	NF ISO 18589-3. COFRAC accreditation No 1-1524. Programme 135.
Carbon-14	Calcine 0.5 g of dry sample using an oxidiser. Recover CO_2 in a mixture of 8 ml of Carbosorb and 12 ml of PermaFluor.	Liquid scintillation counting.	NF M 60 812-2. COFRAC accreditation No 1-1524. Programme 135.
Bound tritium	Combust 30 g of dried sample in an Eraly furnace at 900 °C under an Ar/O_2 gas flow. Recover the tritiated steam in two bubble chambers plunged into a cryostatic bath. Dry distil the phase obtained.	Liquid scintillation counting.	NF EN ISO 9698
Free tritium	Freeze the fresh sample. Freeze dry and recover the water released.	Liquid scintillation counting.	NF EN ISO 9698
Plutonium (alpha-emitting isotopes)	Add ^{236}Pu or ^{242}Pu tracer. Calcine 25 g of dry product at 600 °C. Mineralise the ashes. Coprecipitate the hydroxides. Oxidise the Pu to valence IV. Separate the Pu on anionic resin. Electrodeposition on a Φ19mm stainless steel disc.	α spectrometry on silicon detector.	NF ISO 18589-4

Strontium-90	Calcine 20 g of dry product at 600 °C. Add stable Sr^{2+} carrier and ^{85}Sr tracer. Mineralise the ashes. Purify the strontium by precipitation. Wait t > 15 days for ^{90}Sr - ^{90}Y equilibrium. Add carrier (stable yttrium oxide). Precipitate the yttrium hydroxide. Precipitate the yttrium oxalate. Recover and calcine the precipitate at 900 °C. Depose on a Φ50mm stainless steel planchet. Verify the absence of interfering beta radiation by monitoring the decay of yttrium-90.	Counting of the precipitate in a stainless steel bowl on a counter with low background noise. Determination of the reaction yield of the purification of Sr by spectrometry on a high-purity germanium detector in SG50 geometry. Determination of the reaction yield by weighing the precipitate.	NF ISO 18589-5
Curium	Add ^{243}Am tracer. The start of the preparation process is the same as for the Pu analysis. Recovery of the phase: pass the sample and wash with 9M HCl. Separate Am/Cm on a TRU-Spec column. Eliminate rare earths on anionic resin. Electrodeposition on a Φ19mm stainless steel disc.	Spectrometry on silicon detector.	NF ISO 18589-4

SAMPLES OF SHELLFISH, CRUSTACEANS AND MOLLUSCS (limpets, oysters, mussels, scallops, crabs, lobsters)
Preparing the sample
Boil the samples in water or cook them without water depending on the type of sample, drain and separate the flesh from the shells, dry the flesh in a drying oven at 60 °C to a constant weight, grind mechanically, package the dry product in the geometry suited to the measurement.

SAMPLES OF FISH (round and flat)			
Preparing the sample			
Separate the guts and head from the edible part, dry the flesh in a drying oven at 60 °C to a constant weight, grind mechanically, package the dry product in the geometry suited to the measurement.			
Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference and/or accreditation text**
Gamma spectrometry (qualitative and quantitative)		Direct gamma spectrometry on a high-purity germanium detector in GX200 geometry.	NF ISO 18589-3. COFRAC accreditation No 1-1524. Programme 135.
Iodine-129		Direct gamma spectrometry on high-purity germanium detector with calculation of self-attenuation	NF ISO 18589-3. COFRAC accreditation No 1-1524. Programme 135.
Carbon-14	Calcine 0.5 g of dry sample using an oxidiser. Recover CO_2 in a mixture of 8 ml of Carbosorb and 12 ml of PermaFluor.	Liquid scintillation counting.	NF M 60 812-2. COFRAC accreditation No 1-1524. Programme 135.
Plutonium (alpha-emitting isotopes)	Add ^{236}Pu or ^{242}Pu tracer. Calcine 50 g of dry product at 600 °C. Mineralise the ashes. Coprecipitate the hydroxides. Oxidise the Pu to valence IV. Separate the Pu on anionic resin. Electrodeposition on a Φ19mm stainless steel disc.	Spectrometry on silicon detector.	NF ISO 18589-4
Bound tritium	Combust 30 g of dry sample in an Eraly furnace at 900 °C under an Ar/O_2 gas flow. Recover the tritiated steam in two bubble chambers plunged into a cryostatic bath. Dry distil the phase obtained.	Liquid scintillation counting.	NF EN ISO 9698
Free tritium	Freeze the fresh sample. Freeze dry and recover the water released.	Liquid scintillation counting.	NF EN ISO 9698

SAMPLES OF FRESH WATER (including drinking water)			
Preparing the sample			
No particular preparation.			
Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference and/or accreditation text**
Gamma spectrometry (qualitative and quantitative)	Acidify and package in a geometry.	spectrometry on high-purity germanium detector	NF EN ISO 10703. COFRAC accreditation No 1-1524. Programme 135.
Iodine-129		Direct spectrometry on high-purity germanium detector.	NF EN ISO 10703. COFRAC accreditation No 1-1524. Programme 135.
Gross alpha radioactivity index	Evaporate the water on a planchet.	Counting of the planchet on a low background noise counter.	NF EN ISO 10704. COFRAC accreditation No 1-1524. Programme 135.
Gross beta radioactivity index	Evaporate the water on a planchet.	Counting of the planchet on a low background noise counter.	NF EN ISO 10704. COFRAC accreditation No 1-1524. Programme 135.
Potassium		Flame emission spectrophotometry.	Standard NF T 90-019
Tritium	Distil or pass through a ^{3}H column (Eichrom) if the sample is strongly charged or coloured	Direct liquid scintillation counting.	Standard NF EN ISO 9698. COFRAC accreditation No 1-1524. Programme 135.
Strontium-90	Add stable Sr_{2+} carrier to between 100 ml and 500 ml of sample. Acidify the sample. Separate the Sr on an Sr Spec column (Eichrom). Evaporate the eluate on a Φ50mm stainless steel planchet. Verify the quality of the extraction by checking how yttrium-90 has grown back in.	Counting of the planchet on a low background noise counter. Determination of the reaction yield by atomic absorption.	NF EN ISO 13160. COFRAC accreditation No 1-1524. Programme 135.