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Agence nationale pour la gestion
des déchets radioactifs

2019 version

Summary Memory File

Manche Disposal Facility

CONTENTS

INTRODUCTION

SUMMARY MEMORY FILE - MANCHE DISPOSAL FACILITY
(Basic Nuclear Installation no. 66)

The French National Radioactive Waste Management Agency (Andra) is a state-owned institution responsible for identifying and implementing safe solutions to protect current and future generations against the risks posed by radioactive waste.

Andra has a mission to develop and deploy disposal solutions for:

- high-level waste (HLW) and long-lived intermediate-level waste (ILW-LL), which is the purpose of the Cigéo project;
- long-lived low-level waste (LLW-LL).

Andra also currently operates two disposal facilities in the Aube department of France, one for very low-level waste (VLLW), the other for mainly short-lived low- and intermediate-level waste (LILW-SL).

Lastly, in the Manche department, Andra is monitoring France's first disposal facility for low- and intermediate-level radioactive waste, the Manche disposal facility (CSM), which is currently in its decommissioning-closure phase following the end of operation in 1994.

Some of the radioactive waste that has been or will in the future be disposed of at the various Andra facilities can remain hazardous for long periods (several centuries), and in some case very long periods (thousands or even hundreds of thousands of years).

Preserving the memory of disposal facilities is therefore a crucial issue for Andra, addressed by the *Memory of Radioactive Waste Disposal Facilities for Future Generations program*, which has three aims:

- maintain the integrity of and protect sites by avoiding the risk of unintentional intrusion;
- facilitate and inform decisions by future generations;
- pass on a scientific and cultural heritage.

The regulatory requirements relating to the Andra memory preservation program were introduced by Decree 2016-846 of 28 June 2016, Chapter II of which was devoted to radioactive waste disposal facilities; these requirements were subsequently codified in Article R. 593-75 of the Environmental Code.

In particular, they required the preparation, for each Andra disposal facility, of a "Summary Memory File" (*dossier synthétique de mémoire - DSM*), to include an as-built description of the facility and an inventory stating the location, physicochemical and radiological properties of the waste disposed of at the facility. This file, produced for the general public, is to be widely distributed in the region around the site, but also internationally.

This document is the DSM for the CSM facility.

Its purpose is to inform future generations regarding the existence of the CSM. It provides a broad readership with the necessary information to register the disposal facility in the collective memory, in order to avoid unintentional disturbance, particularly after the end of the 300-year monitoring phase. This measure is relevant because some of the packages disposed of at CSM contain long-lived alpha emitters that remain radioactive for more than 300 years.

The file was designed in two stages:

- in 2008, Andra produced an initial version, known as the "Precis for Future Generations";
- in 2019, a second version of the file was proposed by Andra as part of the CSM's ten-year safety review. It meets the DSM criteria stipulated by the 2016 regulations and takes into account the comments made by the French Nuclear Safety Authority (ASN), the French Institute for Radiological Protection and Nuclear Safety (IRSN) and the public. This second version is presented herein.

The DSM comprises three standalone documents containing graduated levels of information to facilitate understanding of the memorial role:

Leaflet: essential information on one double-sided page.

This document was prepared with inputs from the Manche memory group, a group of local residents who volunteered to study the issue of preserving the memory of the CSM, and from the Semiotics Research Centre (CeReS) at Limoges University;

the Key Information File: an approximately 40-page file intended for the general public.

It is similar to the international *Key Information File* (KIF) concept developed by the "*Preservation of Records, Knowledge and Memory Across Generations*" (RK&M) initiative, led by the OECD's Nuclear Energy Agency (NEA) from 2011 to 2018;

three Thematic Sheets: more precise information on specific technical matters.

- site history;
- regulatory waste inventory;
- risks associated with the disposal facility.

The content of each of these three documents is subject to change, if the need to amend or supplement them arises, for example in the light of each ten-year safety review.

Accordingly, Andra reserves the right to consolidate the following aspects:

- technical aspects, to ensure that any changes to the centre and the most recent monitoring data are included;
- future legibility aspects, to incorporate feedback from readers with very diverse backgrounds, including linguists, in particular by tracking changes in vocabulary usage that might lead to misinterpretation;
- international aspects, to identify other radioactive waste disposal sites (network effect) and translate the document into multiple languages.

In accordance with the regulations, the DSM will be updated during the monitoring phase of the CSM: like the rest of the Andra Memory programme, it is inherently a living record.

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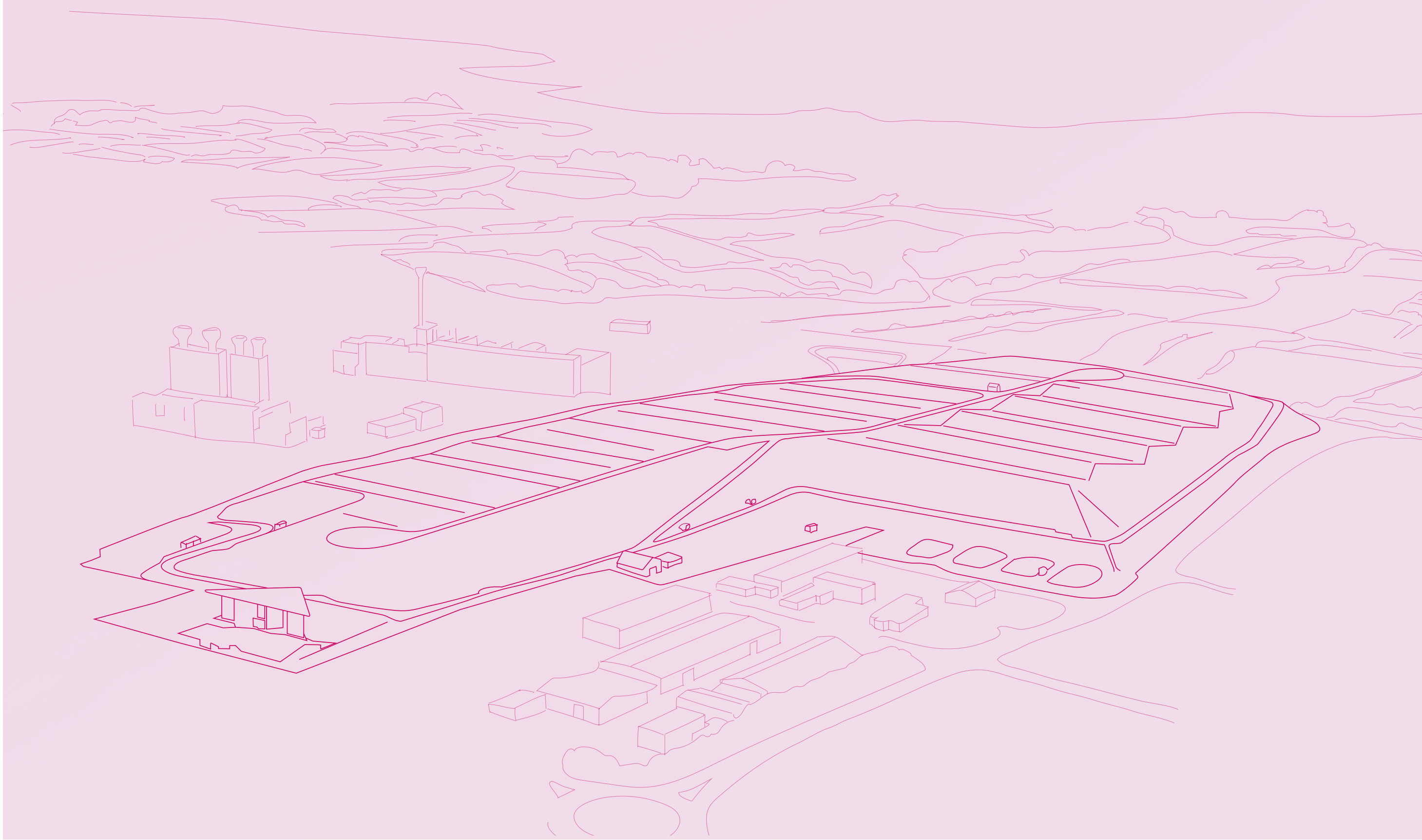
Summary Memory File
Manche Disposal Facility

Leaflet

Memory of the Manche Disposal Facility

The Leaflet is one of three constituent documents of the Summary Memory File, which also includes the Key Information File and a set of Thematic Sheets



THE MANCHE DISPOSAL FACILITY - 2019

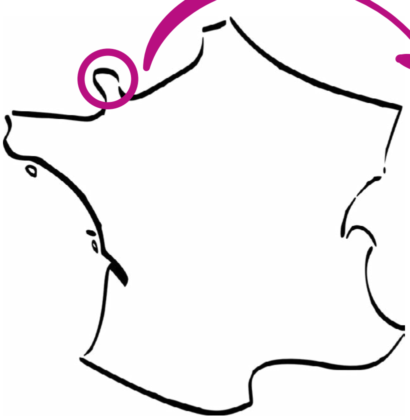
PRESENTATION

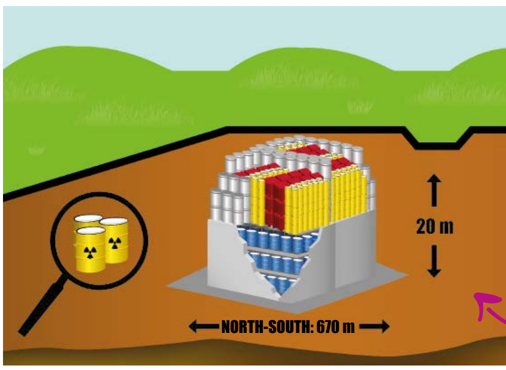
The facility described in this sheet is known as the Manche radioactive waste disposal facility (*Centre de Stockage des déchets radioactifs de la Manche - CSM*). It is a Basic Nuclear Installation (BNI 66).
Low- and intermediate-level radioactive waste, along with toxic chemical compounds, is disposed of at the facility. Radioactive waste was brought to the site over a period from 1969 to 1994. The facility is protected by a multilayer cap comprising different types of materials. The facility, along with its entrances and surrounding environment (fencing and guard services), is and will continue to be monitored by the operator (currently Andra) for three centuries.

The purpose of this sheet is to contribute to the preservation of the site's memory for future generations.

DESCRIPTION OF THE DISPOSAL FACILITY

Waste is covered with a multilayer cap several metres (min. 2 m) thick.





Latitude and longitude coordinates are stated in sexagesimal degrees relative to the Greenwich meridian – altimetry

SURFACE AREA: 150,000 m²
HEIGHT: 5 to 20 m
MAXIMUM LENGTH x WIDTH x HEIGHT: 670 m x 320 m x 20 m WASTE VOLUME: 527,225 m³

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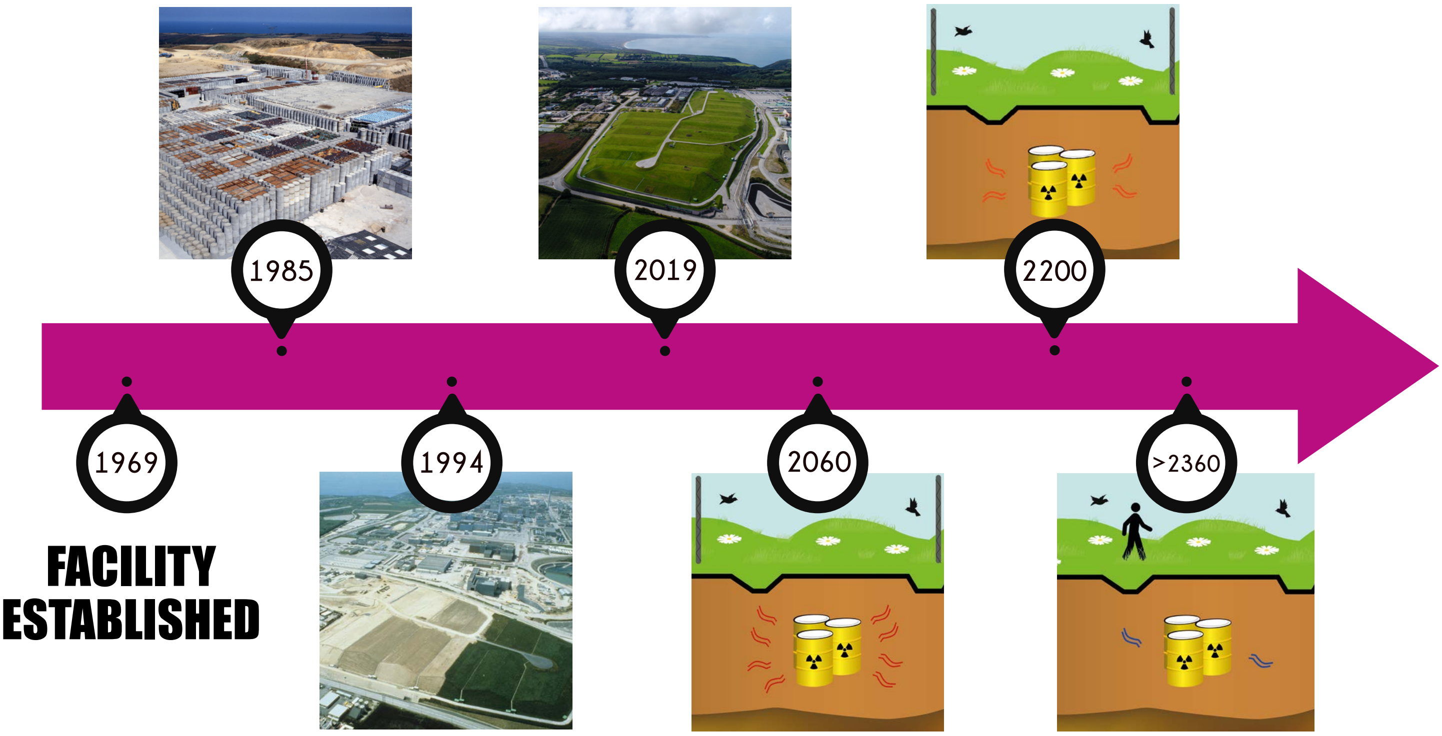
HISTORY AND FUTURE OF THE SITE

After the 300-year monitoring period, a residual hazard will remain, essentially due to the presence of toxic chemical compounds and long-lived radioactive elements, requiring precautions in terms of the site's use – See "Site use" below.

The current plan is for the site to evolve naturally following the departure of the operator after 300 years. Access will no longer be controlled and the site use precautions are subject to review.



SITE USE RESTRICTIONS

NO EXCAVATION

NO CONTACT WITH WASTE DISPOSED OF

NO USABLE WATER RESOURCES

NO CONSTRUCTION PERMITTED

MORE INFORMATION

This document is part of the facility's **Summary Memory File** (DSM).
Where to find documentation preserving the memory of the site:

- The **Summary Memory File (DSM)** will be widely distributed (to council offices, land registries, notaries, Departmental Archives, National Archives, etc.). The DSM also includes a key information file (40 pages) and some thematic sheets.
- The **Detailed Memory File (DDM)**, consisting mainly of technical documents, is archived by Andra and at the National Archives of France.

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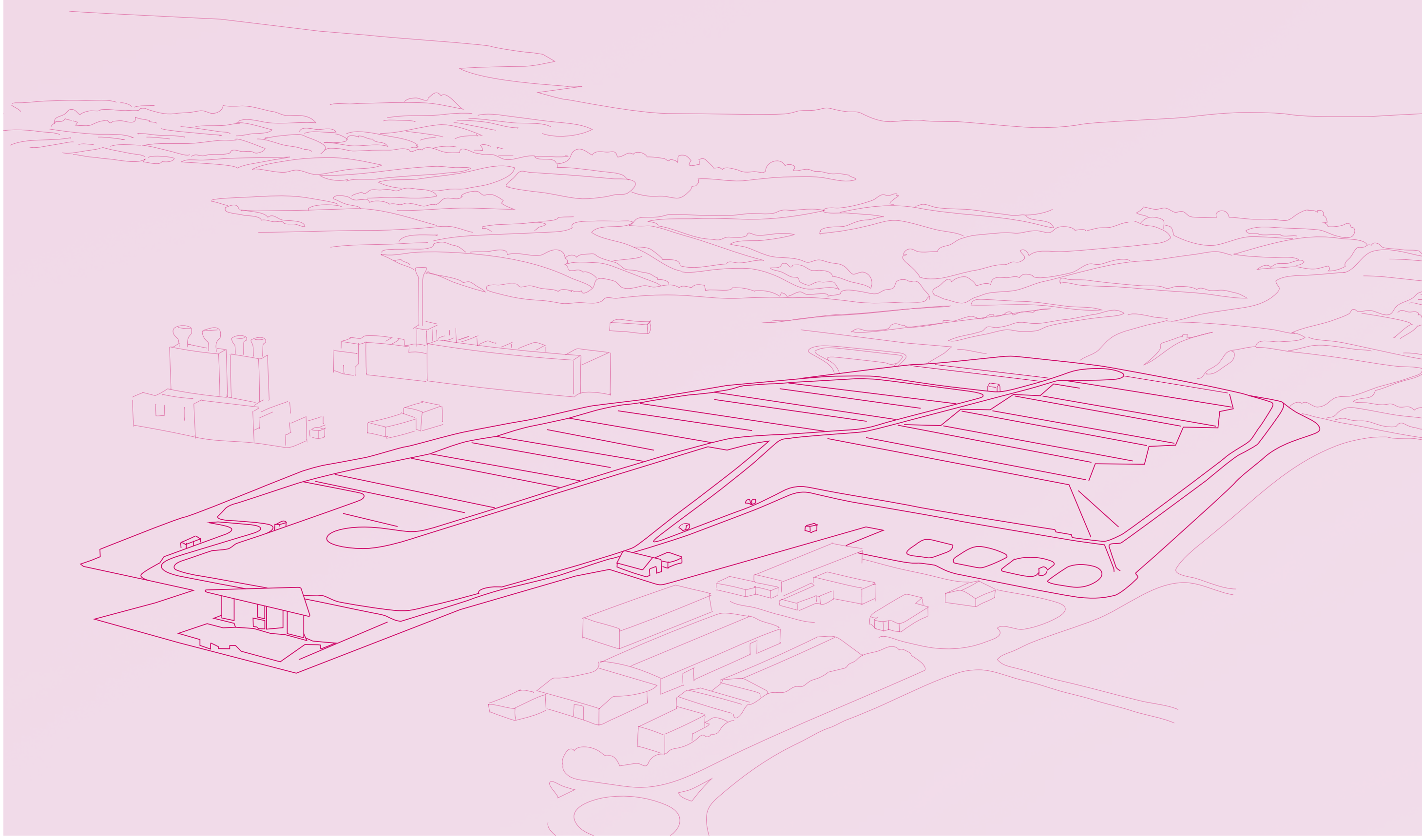
Summary Memory File
Manche Disposal Facility

Key Information File

Memory of the Manche disposal facility

The Key Information File is one of three constituent documents of the Summary Memory File, which also includes the Leaflet and a set of Thematic Sheets



Draft
Key Information File for the
Manche Disposal Facility

0. Introduction
1. Background
2. The Manche disposal facility (CSM)
3. Disposal facility design
4. Waste disposed of at the facility
5. Site monitoring and evolution
6. Long-term memory of the Manche disposal facility
7. Radioactive waste disposal facilities worldwide

INTRODUCTION

Lest we forget...

This document was issued in March 2019 by the French National Radioactive Waste Management Agency (Andra). Its purpose is to inform future generations, especially local residents, regarding the existence of a radioactive waste disposal facility located in the municipality of La Hague (Digulleville), 20 km northwest of Cherbourg-en-Cotentin in the Manche department of France.

The Manche disposal facility (*Centre de stockage de la Manche - CSM*) mainly houses radioactive waste, but also toxic chemical compounds that can be hazardous for humans and the environment. A system of isolation measures has therefore been implemented to protect future generations against this hazard. For this protection to remain effective, the isolation system must not be disturbed.

IN BRIEF

What is in this document?

- Chapter 1 addresses the nature of radioactivity, discusses the hazards associated with radioactive waste and describes the basic management principles that led to the creation of the Manche disposal facility.
- Chapter 2 indicates the location of the Manche disposal facility, identifies the main characteristics of the host site and lists the principal milestones in its history
- Chapter 3 covers the design of the Manche disposal facility
- Chapter 4 provides information on the waste disposed of at the site and the related risks.
- Chapter 5 describes the monitoring measures and assesses the impact of a hypothetical intrusion.
- Chapter 6 discusses the distribution and updating of this document and presents the documents that provide additional information.
- Chapter 7 contains a list of similar radioactive waste disposal facilities around the world.

Document intended for widespread distribution

For this document to fully serve its purpose, as many people as possible must be able to access and understand it. It falls to you who hold it in your hands today to ensure that future generations, particularly people living near the facility, can access it, understand what is written in it, and in turn pass it down to subsequent generations in good conditions.

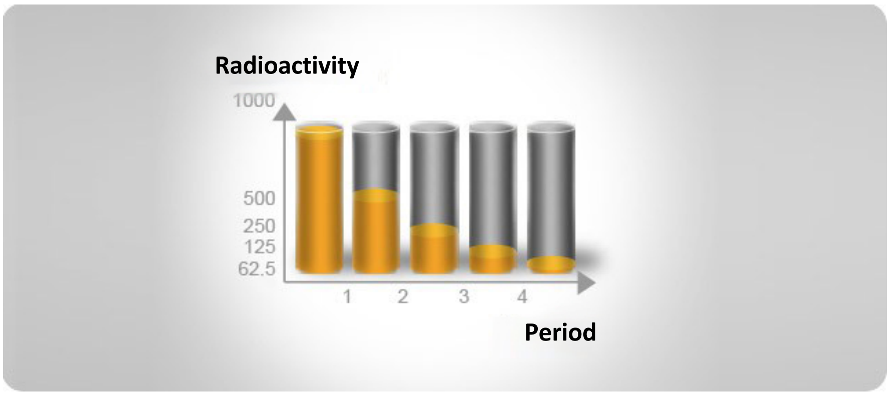
1 BACKGROUND

Humans have harnessed the natural physical phenomenon of radioactivity for a range of applications. These activities produce radioactive waste, which must be isolated using appropriate management methods as it is harmful to human health and the environment. The Manche disposal facility (CSM) accommodates low- and intermediate-level radioactive waste*[1], emplaced in disposal structures that ensure containment.

WHAT IS RADIOACTIVITY?

Radioactivity is the property whereby certain unstable atoms disintegrate, emitting radiation and energy. This naturally occurring phenomenon can also be caused by humans, in a nuclear reactor. This is referred to as man-made radioactivity.

Radioactive atoms are called radionuclides. The radioactive period* (or half-life*) is the time required for a radionuclide to lose half of its radioactivity. This time varies between radionuclides.



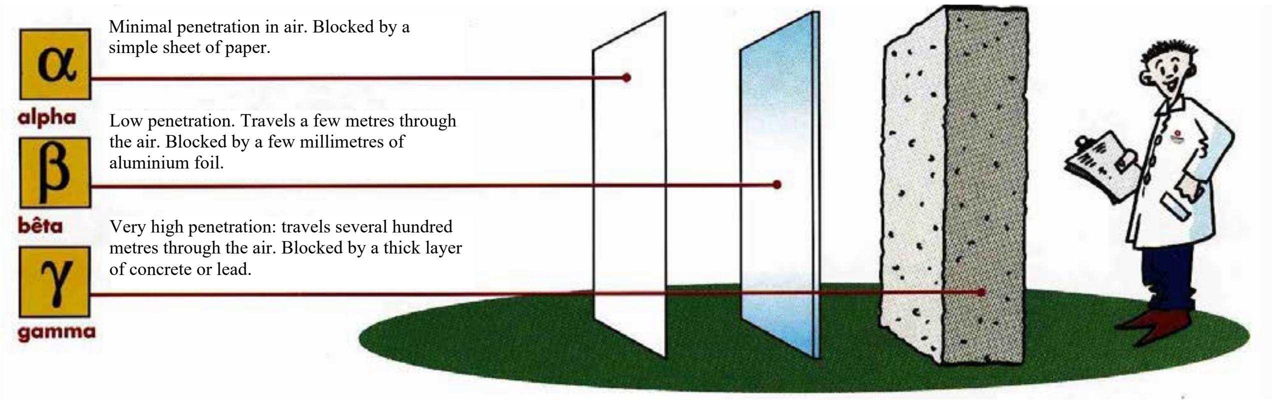
The radiation emitted by disintegrating (or decaying) radionuclides can take several forms.

Some are highly penetrating, while others are blocked by even a sheet of paper. This irradiation can cause changes in biological organisms. It is therefore important to protect against irradiation, using means appropriate to the hazards.

The radioactivity of a material is measured in Becquerels*, determined by the number of atoms that disintegrate per second. This depends on the nature and concentration of the radionuclides contained in the material.

[1] Terms marked with an asterisk are defined in the glossary at the end of the document. The asterisk is repeated the first time the word is used in each chapter.

Penetration power of radiation



MORE INFO

Types of radiation

Radionuclides emit invisible radiation of different types and intensities, called alpha*, beta* and gamma*. Alpha rays are more massive (with helium nuclei, consisting of two protons and two neutrons) and therefore less penetrating than beta rays (electrons or positrons) and gamma rays (photons). Alpha-emitting radionuclides are typically longer-lived than beta or gamma-emitting radionuclides. However, all the radioactive waste at the Manche disposal facility contains a mixture of radionuclides, each with its own radiation characteristics. The overall activity of the waste will have greatly decreased by the end of the initially planned 300-year monitoring period, but residual alpha radioactivity will continue to represent a hazard for human health and the environment. It will therefore be necessary to restrict how the site is used for a very long time after the monitoring period.

RADIOACTIVE WASTE

- ### Where does radioactive waste come from?

Man-made radioactivity is used in a variety of applications:
- electric power generation (at nuclear power plants)
- medicine (radioactive sources can be used to locate diseased cells in the body, treat cancers, sterilise medical and surgical instruments, etc.)
- research (e.g. using traces of a radioactive element to mark a molecule in order to study its behaviour)
- industry (radiographic testing to detect cracks in welded joints, preservation of foodstuffs by destroying bacteria, etc.)

Using radioactivity generates radioactive waste. This waste is very diverse in nature, with varying levels of radioactivity, measured in Becquerels.

- **What are the sources of the radioactive waste sent for disposal at CSM*?**

The Manche disposal facility contains low- and intermediate-level waste. Most of the radionuclides are short-lived (with radioactive periods shorter than 31 years). Most of this waste comes from the various CEA* research facilities and EDF power plants, and from reprocessing spent nuclear fuel at the La Hague site adjacent to CSM (reprocessing originally carried out by the CEA, then by Cogema, which subsequently became Areva* and then Orano*).

DID YOU KNOW?

Where does low- and intermediate-level radioactive waste come from?

This category of waste includes:

- waste from the operation and maintenance of nuclear power plants and research laboratories: clothing, gloves, shoes, rags, tools, etc.
- nuclear decommissioning waste
- some sealed sources* that have ceased to emit sufficient radioactivity for their intended use in medicine, industry, education or agriculture

- **How has this type of radioactive waste been managed in the past?**

Prior to establishing the Manche disposal facility in 1969, dumping at sea was considered the most appropriate management solution for radioactive waste. In France, with effect from 1969, this practice was maintained only for waste from nuclear testing in the Pacific Ocean. It was abandoned in 1983. In 1993, the signatories to the London Convention agreed to ban marine dumping for all types of radioactive waste.

Between 1969 and 1994, the Manche disposal facility received waste sent for surface disposal.

From 1992, the Aube disposal facility (CSA) took over from the CSM regarding the management of radioactive waste deemed acceptable for surface disposal.

DID YOU KNOW?

Feedback

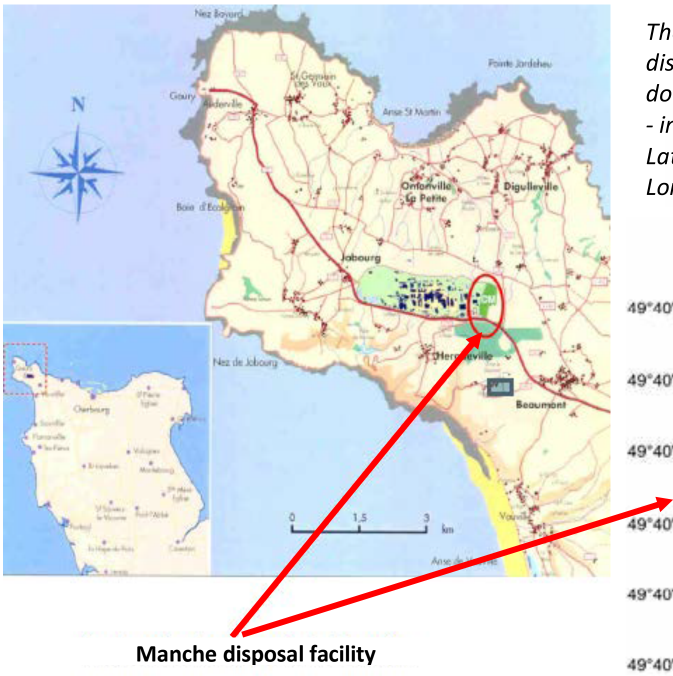
The Aube disposal facility, located in Soulaines-Dhuys in the Champagne-Ardenne region, has been receiving low- and intermediate-level waste since 1992. Designed after the Manche disposal facility, it incorporates operating feedback from the existing centre.

2 MANCHE DISPOSAL FACILITY

The Manche disposal facility is located at the northwest tip of the Cotentin peninsula, in a geographical area with a marked oceanic climate and a complex geological environment. Feedback obtained during its operating period from 1969 to 1994 was instrumental in the adoption of a comprehensive policy on radioactive waste management in France.

PRESENTATION

The Manche disposal facility is located at the northwest tip of the Cotentin peninsula, about 20 km west of the city of Cherbourg-en-Cotentin. It lies at the southern edge of the municipality of La Hague (Digulleville) in the Manche department, and on the eastern edge of the La Hague spent fuel reprocessing plant. The site extends over an area of approximately 15 hectares.



The geographical coordinates of the Manche disposal facility (corresponding to the blue dot shown on the map) are as follows:
- in decimal degrees:
Latitude: 49.6770 (i.e. 49° 40’ 37’’)
Longitude: -1.8630 (i.e. -1° 51’ 47’’)

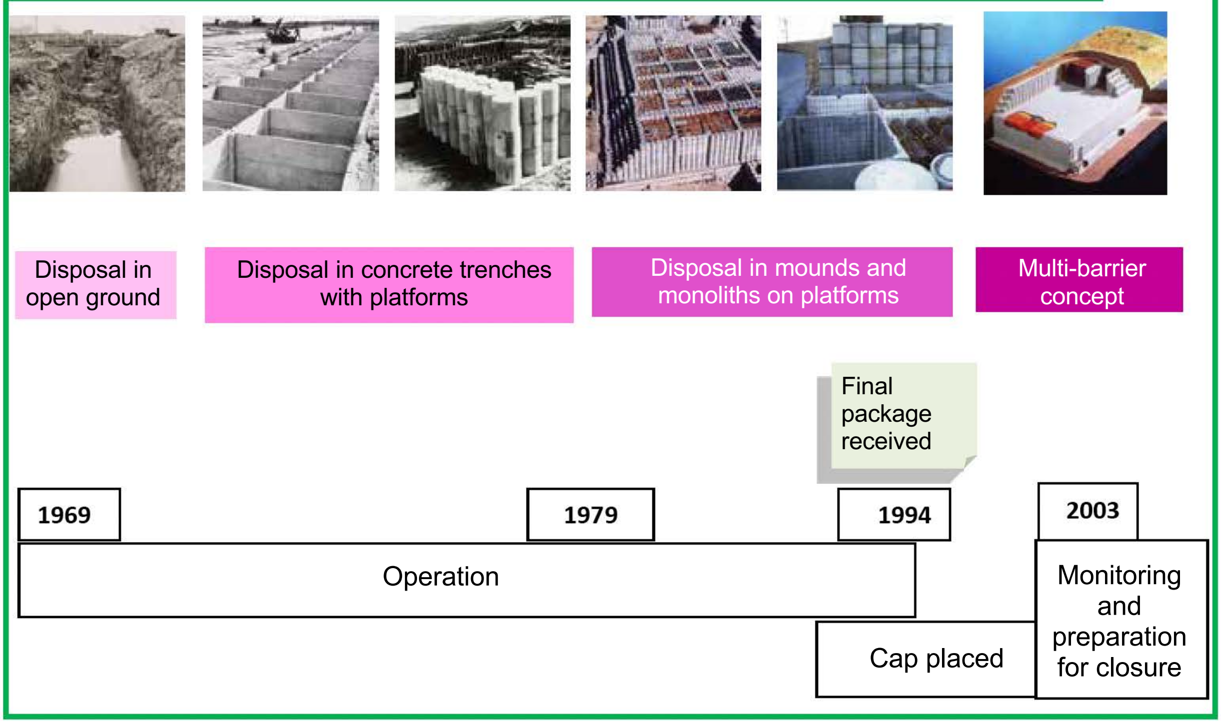
HISTORY

The Manche disposal facility (*Centre de la Manche - CSM*) is France's oldest radioactive waste surface disposal facility.

Established in 1969 following France's decision to end marine dumping of radioactive waste, CSM was built on the edge of a CEA* research centre, on land owned by the CEA. The West area of the site was selected because it had the most suitable hydrogeological properties.

Disposal techniques evolved considerably over the period between placing the first and last packages (i.e. 1969 to 1994). These changes were due in part to the experience gained during the operating period, but also to regulatory changes.

CHANGES IN CONSTRUCTION TECHNIQUES EMPLOYED FOR WASTE DISPOSAL FACILITIES



ENVIRONMENT

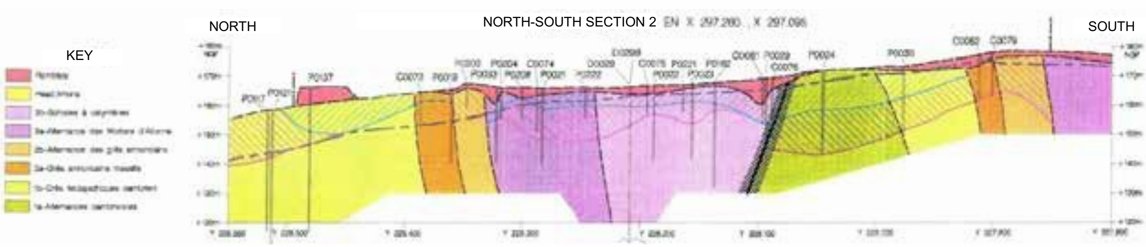
- **Geological environment**

The chemical and physical properties of the geological environment delay migration of radioactive substances and limit their radiological and chemical impact. Understanding these parameters is therefore important.

The Manche disposal facility is located on a very old geological massif, generally referred to by geologists as bedrock. This bedrock contains folds and fractures resulting from a series of deformation phases. There are two main types of rock: alternating layers of shales* and sandstones* in a near-vertical position.

The properties of these rocks help to limit the migration of radioactive substances. Additional measures have been implemented, including a multilayer cap that protects waste from rainwater, erosion, etc.

However, because of the presence of the disposal facility, there is a possibility that substances from the facility may enter the downstream watercourses presented below. It is important to monitor the water quality in these streams.



The geology of the Manche disposal facility is old and complex The bedrock on which the disposal facility sits consists of folded sedimentary rocks from the primary era (in vertical layers).

Hydrological and hydrogeological environment (2015 data)

The Manche disposal facility is sited at the head of a catchment basin with a limited hydrographic network. Three streams run near and below the CSM*, in a south-to-north direction:

- **Ruisseau de la Sainte-Hélène**

This stream, situated to the north-northwest of the CSM, flows into the sea after a journey of about 3 km.

- **Ruisseau du Grand Bel**

This stream, which has its source to the north-northeast of the CSM, runs into the Sainte-Hélène stream after 1.7 km.

- **Ruisseau des Roteures**

The source of this stream lies east of the CSM. After flowing for around 1 km, it runs into the La Vallace stream, which in turn flows into the sea north-northeast of the disposal facility.

Independently of the existence of the Manche disposal facility, the water in these streams is naturally unfit for consumption.

Location of the streams near the Manche disposal facility.

Hydrology:
Runoff from the Manche disposal facility flows into the Sainte-Hélène stream.

Hydrogeology:
Groundwater flowing under the site feeds the Grand Bel and Sainte-Hélène streams, and to a lesser extent, the downstream section of the Roteures.

Manche disposal facility

MORE INFO

Groundwater characteristics in 2018

The groundwater flowing under the CSM can be considered of poor quality. From a physicochemical perspective, it contains:

- Chemical toxics and metals, including in particular zinc, iron, manganese and aluminium, but also mercury, both upstream and downstream of the site,
- Nutrients such as nitrates and sulphates.

These substances present in the groundwater both upstream and downstream of the site are tracers of the industrial and farming activities across the broader area.
Drinking this water is not recommended.

From a radiological point of view, this aquifer currently bears traces of tritium, attributable partly to the operation of the CSM but mainly to the tritium incident of 1976 (see insert in Chapter 3). Its radiological activity is decaying significantly, on a human scale.

Climate (2018 data)

Flanked on three sides by the English Channel, the Cotentin peninsula is subject to a very marked oceanic climate:

- strong winds (blowing at an annual average speed of 7 metres per second), with south-westerly prevailing winds
- significant average annual rainfall (approximately 1 metre per year)
- high humidity (79-92%)
- cool but temperate average annual temperature (around 10°C)
- 1,650 annual sunshine hours, on average

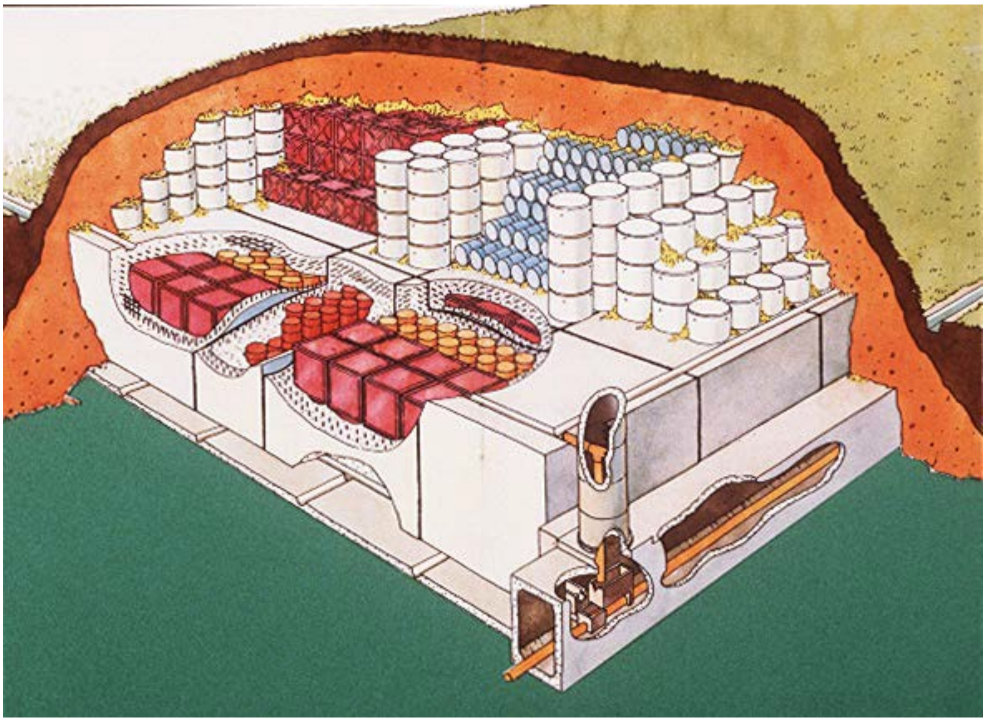
3 DISPOSAL FACILITY DESIGN

The Manche disposal facility - the first surface disposal facility created in France for the purpose of managing radioactive waste - has evolved over time. This chapter presents the general design of the facility and the main developments that have influenced its design and operation.

GENERAL DESIGN

The centre consists of several disposal structures, built over the years as and when new waste capacity was required.
Waste packages* were disposed of in units called disposal structures. Over the course of the CSM's operation, these structures, arranged in rows, were filled with packages on two levels, proceeding from north to south. Overall, the CSM* layout reflects its three operating phases, with the oldest structures (phase no. 1) in the northern part of the site and the most recent structures (phase no. 3) in the south.
The disposal structures have seen some major technical developments over the 25 years of operation of the site, in order to better isolate radioactivity and improve water management.

The diagram below shows the distribution of the different types of packages at the facility.



Cutaway diagram of the disposal facility, illustrating the layout of the different types of packages.

DESIGN CHANGES TO WASTE PACKAGES AND DISPOSAL STRUCTURES FROM 1969 TO 1994

A number of changes were made throughout the period during which the CSM received waste, concerning the waste acceptance criteria and related administrative procedures, as well as the design of the disposal structures in which the waste packages were placed.

• Waste acceptance criteria

To be accepted at the disposal site, a waste package had to meet certain criteria, relating to its radiological composition in particular. The first step was to check that its activity level met the regulatory criteria, which have changed over time. Secondly, as each package contained a mixture of radionuclides with different shelf lives, it was also necessary to check that the quantity of long-lived radionuclides (with a radioactive period longer than 31 years) was below a certain threshold, above which particular specifications (in terms of acceptable activity limits or special packaging) were applicable.

Waste packages arriving at the CSM were accompanied by an information sheet describing their radiological content. This information sheet (in the form of a paper “slip”), which was not very detailed during the early years of operation, has been gradually enriched with additional information. With effect from 1985, this information was directly included in a computer database.

MORE INFO

Tritium Incident

During the operating phase of the Manche disposal facility, a major event occurred in 1976. This incident had an impact on the facility’s design and operation, particularly as regards the type of waste accepted.

Tritium is a radioactive isotope* of hydrogen, which is a particularly light and mobile chemical element. In 1976, an abnormal tritium concentration was detected in the Sainte-Hélène stream situated downhill from the Manche disposal facility. A combination of heavy rain and operating incidents affecting a pump led the concrete trench drainage network to overflow at the surface, flooding to a depth of several centimetres the tritium-rich waste in concrete trench no. 2 (aka "TB2"), located to the north-east of the facility.
The most highly contaminated waste was removed, to minimise contamination of the subsurface and groundwater; this waste was stored at a CEA* site until its activity decayed. The remainder was relocated to the Manche disposal facility for disposal in suitable structures. Following this incident, the structures’ drainage system was supplemented with a new network, known as the "separative water collection system", and the acceptance criteria were clarified. Tritium-containing waste was subsequently accepted at the facility only in small quantities.
In 2018, tritium labelling* was still being detected in the groundwater and nearby streams, particularly the Grand Bel.

• Use of waste packages

When the CSM began operating in 1969, waste was packed into packages that were in turn placed in a disposal structure.

The waste packages received at the CSM consisted of:

- packaging (or enclosure) made of either metal (drum or box) or concrete (hull or block);
- waste, in any of several forms, depending on its level of radiological activity:
    - coated*, that is to say mixed with cement, bitumen or a resin to guarantee the mechanical strength of the package and ensure that water licking does not present a hazard;
    - fixed*, i.e. mixed with cement or a resin to ensure the mechanical strength of the package (with no water licking performance guarantees);
    - loose, with no performance guarantees relating to either mechanical strength or water licking.

In the earliest years of disposal operations, low-level waste was neither coated nor fixed inside the drums.

Packaging methods very soon evolved to reflect the nature of the waste and its level of radioactivity, and the injection of coating materials was systematically adopted, in particular to ensure the stability of packages in the disposal structures (waste packages are stacked on several levels).

All waste disposed of inside the Manche disposal facility was packed in waste packages, apart from a small quantity of earth included in the base of the cap.

MORE INFO

Package data

Each waste package disposed of at the CSM bears an identification number (originally handwritten, then bar-coded in the 1990s). This number refers to essential information such as the package's weight, dimensions, the radioactive substances contained and its radiological activity.

All packages disposed of at the CSM have been recorded in a computer database named "COCAS-RP2".

• Disposal structures

Operating feedback from the initial disposal structures informed a series of changes to the rules. Two categories of disposal structure currently exist:

- trenches: most of these structures are old. They include ordinary trenches (TO, of which only TO3 remains) and concrete trenches (TB).
- Platforms: these structures are organised into either "tumuluses" or "monoliths", depending on the activity and nature of the packages.

Trenches

Ordinary trenches

The original disposal structures were open trenches dug directly into the ground, in which to deposit low-level waste. This type of structure was quickly abandoned, mainly because of operational difficulties. Only one of these trenches has been retained (trench TO3); another was never put into operation (TO2) and has been filled in with soil; trench TO1 was reworked, and its packages retrieved and placed in other structures.

Ordinary disposal trench (1969)

MORE INFO

Ordinary trenches
Ordinary trenches were dug in open ground, to contain only low-level waste. This type of structure was soon abandoned.

Of the three ordinary trenches initially planned, only trench TO3 remains, as the activity of the waste disposed of in it did not justify a recovery effort.

The structure above TO3 was designed with a special apron to bear loads on either side of trench TO3, limiting the risk of settlement (structure T24-2).

Concrete trenches

Waste containing the highest levels of radiological activity was disposed of in long trenches lined with walls made of 10 cm thick precast concrete slabs that were assembled in situ (see photograph below). The bottom and walls are sealed with a bituminous sealant. The bottom of the trench is equipped with a drainage solution.

Concrete trenches under construction (1969)

MORE INFO

Concrete trenches

Concrete trenches were built to accommodate waste containing the highest levels of radiological activity, i.e. above the threshold defined by the 1969 decree establishing the facility.

The bottom and walls are sealed with a bituminous sealant.

The bottom of the trench was first levelled with a layer of sand that also performs a drainage function.

To enable waste packages to be retrieved in the event of hypothetical difficulties, the cells in the first trenches were filled in with sand without cement.

In 1976, abnormal tritium activity was detected in the Sainte-Hélène stream, and the structure responsible for the incident was quickly identified as TB2.

Following the 1976 tritium incident, the sand was removed and replaced with mortar. Once filled, the cells were covered with a reinforced concrete slab, which served as a foundation raft for the structures above it.

Platforms

Platforms differed from ordinary trenches in featuring an area facilitating the approach of transport and handling equipment.

Disposal platform (1971)

MORE INFO

Platforms

In the early stages of operation, the platforms consisted simply of crushed coarse aggregate coated with low-dose bitumen. Over the years, they evolved into increasingly thick, increasingly reinforced and increasingly leaktight concrete structures (the platform structure is often referred to as its "foundation raft").

The disposal area was levelled, with a slight slope to evacuate rainwater during the radioactive waste package placement phase. These flows were directed into stormwater collection sumps. These systems were subsequently reworked and connected to a so-called effluent collection system, which subsequently became the "separative water collection system". This system made it possible to separately manage rainwater and effluents that had come into contact with waste.

Two disposal methods were used, depending on the characteristics of the package:

- if the package alone did not provide sufficient protection against radioactivity, it was sent to a disposal structure known as a "monolith", the voids in which were filled with concrete – see below.
- if the package afforded adequate intrinsic safety, it was routed to a "tumulus" structure consisting of a stack of packages backfilled with a filler material (gravel or sand) - see next page.

<u>Monolith structures</u>

Monoliths are parallelepipedic blocks containing concrete-coated packages. The walls of some monolith structures consist of concrete packages stacked and cast into a cement matrix. The walls of the remaining structures are made of concrete, with steel reinforcement along each of their six faces for additional cohesion and mechanical strength. Monoliths are erected on a concrete platform or other host structure. Two types of monoliths were constructed, according to whether or not the radioactive waste packages were irradiating: ordinary monoliths and irradiating monoliths.

Disposal in monoliths (1985)

Tumulus structures

Tumulus disposal structures consist of stacks of radioactive waste packages, the gaps between which are filled with gravel. To ensure good overall mechanical strength and facilitate disposal operations, the frame of these structures was constructed with concrete-shelled waste packages in a tiered arrangement along the edges of the structure, defining the shape of a gently sloping mound containing the vertically-stacked waste (see photograph below).

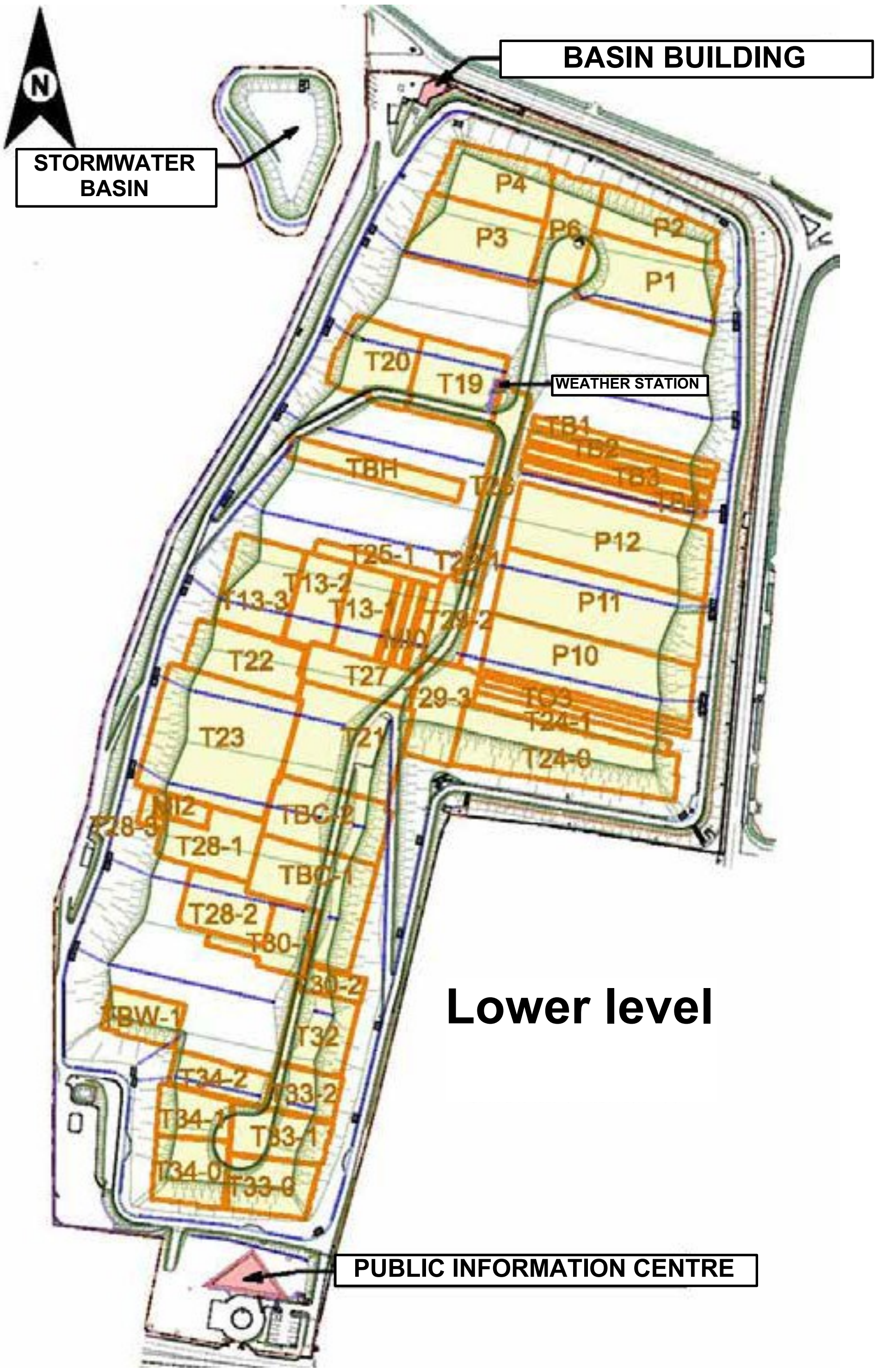
Tumulus disposal structure (1988)

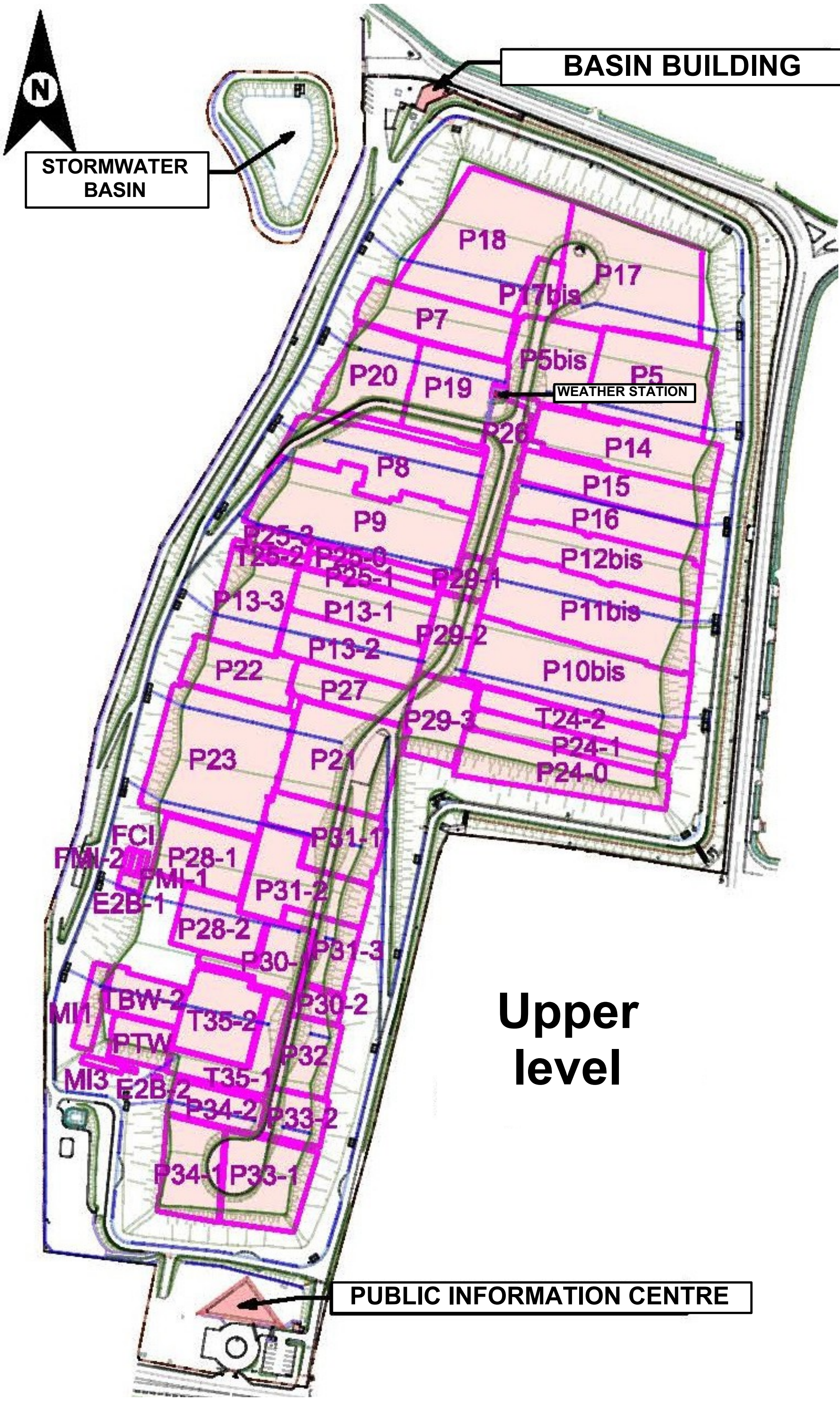
Special structures

The CSM has several special structures, including the "ELAN IIB" structures and "alpha sumps": these structures are legacy disposal structures for packages that have been reconditioned onsite. Once the packages they contained had been reconditioned, these structures were converted into final disposal structures, respectively named the ELAN IIB structure and the irradiating monolith structures FCI0, FMI1 and FMI2. They are located at the top end of the facility.

Disposal structure layout plan

The locations of the disposal structures are shown in the figure below, which distinguishes between the structures located on the upper and lower levels.





BASIN BUILDING
N
STORMWATER BASIN
P18
P17
P17bis
P7
P5bis
P5
P20
P19
WEATHER STATION
P26
P14
P8
P15
P9
P16
P25-3
T25-2
P25-0
P25-1
P12bis
P29-1
P13-3
P13-1
P11bis
P29-2
P13-2
P22
P10bis
P27
P29-3
T24-2
P24-1
P23
P21
P24-0
FCI
P31-1
FMI-2
P28-1
FMI-1
E2B-1
P31-2
P28-2
P30-1
P31-3
MI1
TBW-2
P30-2
T35-2
PTW
P32
MI3
E2B-2
T35-1
P34-2
P33-2
P34-1
P33-1
Upper level
PUBLIC INFORMATION CENTRE

DESIGN CHANGES BETWEEN 1994 AND 2018

Following the end of the CSM's operating phase, the design changes no longer concerned the disposal structures but the cap placed over them. This cap is intended to protect the disposal facility against water infiltration (for a few centuries) as well as the risk of uncovering waste packages (due to erosion, in particular). In 2009, 2010, 2011, 2012 and 2013, work was carried out to consolidate the cap and make its embankments less steep.

The quality and stability of the cap are the subject of regular studies, reports and assessments.

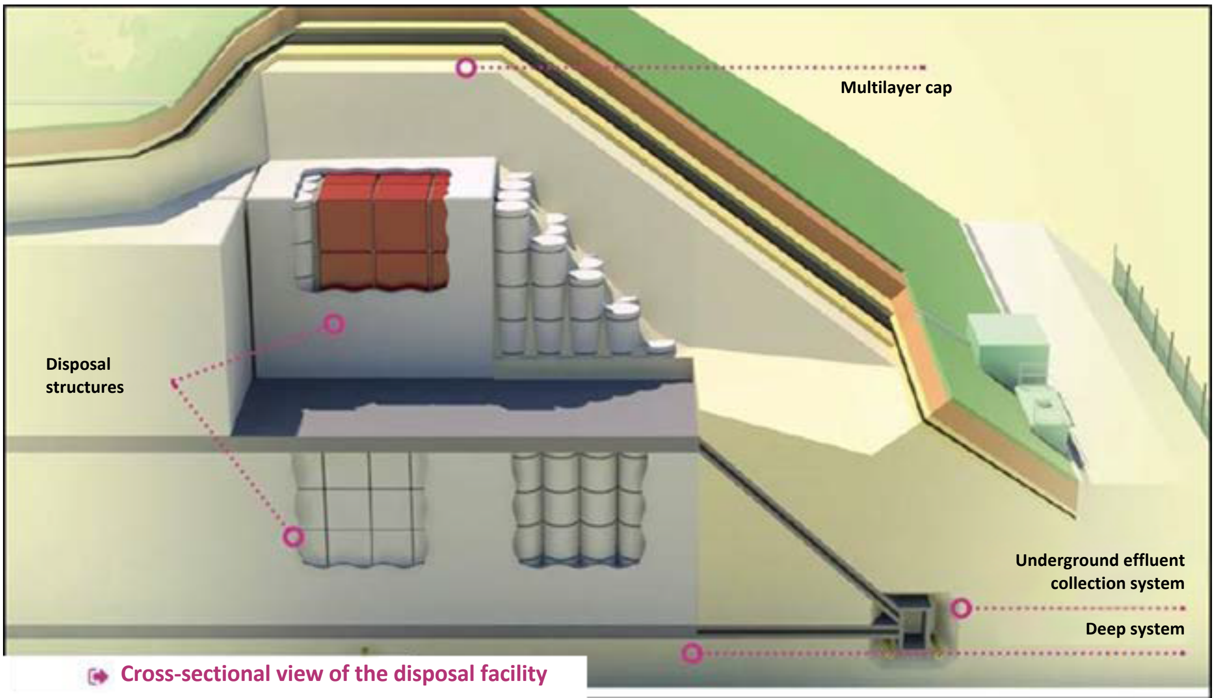
THE DISPOSAL FACILITY IN 2018

- ### Disposal structures

As it currently stands, the Manche disposal facility resembles a large, grassy mound. The waste packages and disposal structures are now covered by a multilayer cap consisting of alternating drainage and impermeable layers.

Depending on the structure, the packages may be concrete blocks or metal containers, in relatively standard sizes. There are also "non-standard" packages, in all shapes and sizes. Inside these packages, waste may be disposed of in bulk, fixed, or coated within a cement or bitumen matrix. Some waste is compacted before being cast into a matrix. Inside the disposal structure, packages may have deteriorated to varying extents, or even disintegrated entirely, leaving the waste in bulk.

Several networks of underground tunnels underneath the disposal structures are used to monitor and collect any water infiltrating the disposal structures, potentially coming into contact with waste packages.



Cross-sectional view of the disposal facility

To the north of the facility, the technical building contains all the outlets from the various water collection systems, spill retention tanks and pre-inspection holding tanks. These systems, which are located at various levels of the cap under the disposal structures, allow the differentiation and separate management of stormwater and effluent collected under the disposal structures and ancillary facilities.

To the south, the public information centre accommodates the staff offices, a permanent or temporary exhibition space, the archive room and the guard facilities.

- **Water management**

Four water collection systems were constructed, on the surface and at various depths, in and around the cap, retaining walls, disposal structures, etc., to allow separative water collection.

Collected water is monitored (measuring flow rates as well as physicochemical and radiological properties) and routed to appropriate outlets, based on its nature and potential radioactive contamination:

- "At-risk" water may be contaminated, and as such is routed to the management facilities devoted to at-risk systems at the Orano* La Hague plant adjacent to the Manche disposal facility, and then discharged into the sea through a dedicated outfall pipe. This category includes drainage water from disposal structures, the drainage water from the various layers of the cap, and deep drainage water from the disposal facility as a whole.
- “Stormwater” is inspected and then discharged into the Sainte-Hélène stream, via the storm basin’s water management systems and then the Orano stormwater management facilities. This category of water includes runoff from the cap, buildings and roads, as well as some drainage water from the multilayer cap (overflow resulting from flow rates greater than 30 m^3/h).

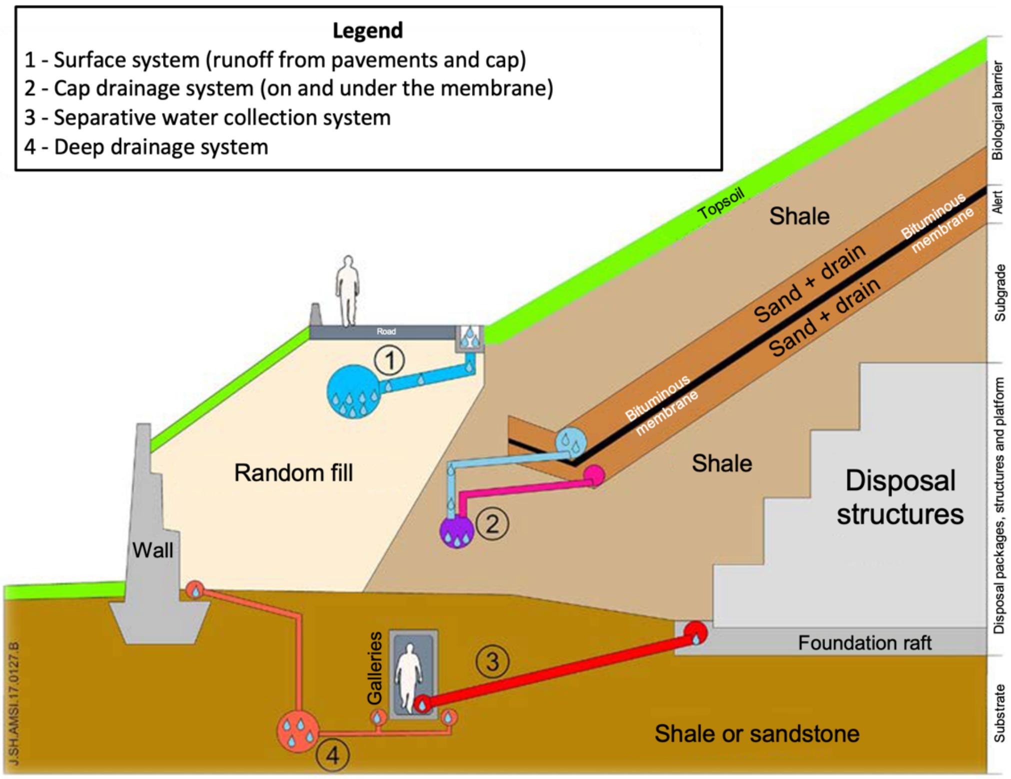
MORE INFO

Four water collection systems

Four different systems were installed to collect water:

- a surface system collecting runoff (stormwater) from the cap. This system consists of gutters and pipes that direct the collected water to buried main drains (0.8 m and 1 m in diameter) that run around the site perimeter and lead into the "stormwater" collection chamber (CMG) in the northwest corner;
- a drainage system collecting infiltration water from the upper two layers of the cap, namely topsoil and the biological barrier (see the next "More information" box), which leads into the bituminous membrane drain, as well as any drainage water that may have penetrated the bituminous membrane;
- an underground system known as the "separative water collection system", designed to recover water that has infiltrated through the waste packages by collecting it from the base of the disposal structures: the water thus collected presents a risk of radioactive contamination and is treated as "at-risk water";
- a deep drainage system, located at the base of the buried facilities (running along the galleries of the underground system) behind the retaining walls or underneath the disposal structures. Water collected by this system also presents a risk of radioactive contamination and is therefore included in the "at-risk" category.

These four systems are shown in the diagram below



Multilayer cap system

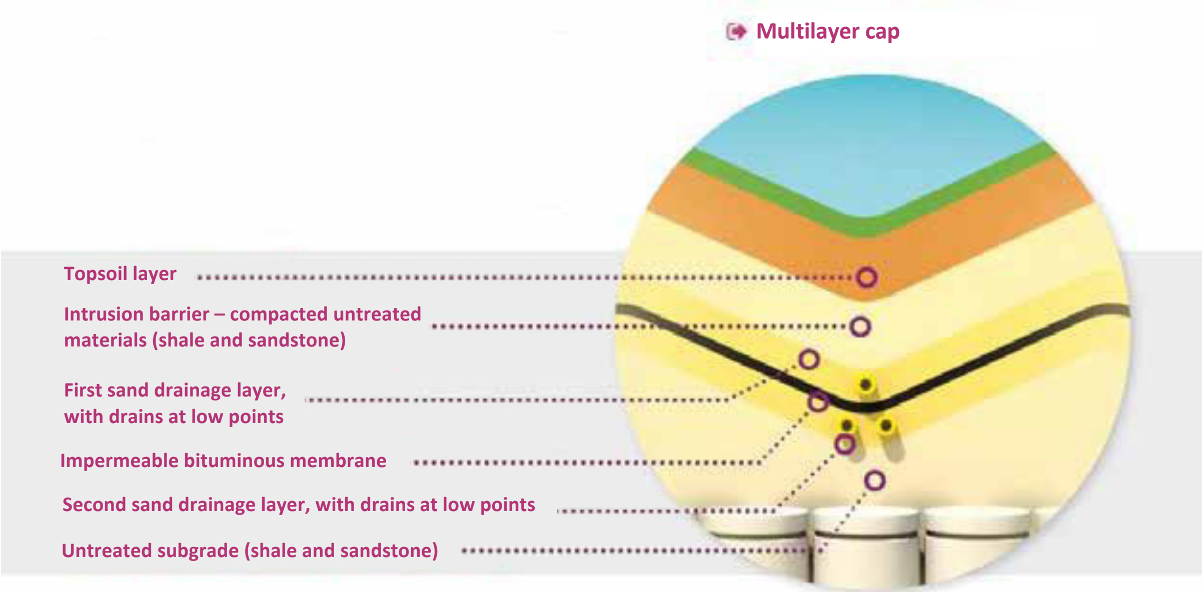
The cap covering the disposal facility plays a key role in its safety, now that the last waste package has been delivered. In particular, it must protect the waste against:

- stormwater (to avoid radioactive substances becoming dispersed in groundwater)
- erosion and the consequences of climate change,
- disturbance by humans (intrusion, etc.), animals (burrowing animals) or plants (roots).

To enable the cap to fulfil this purpose, two criteria were adopted regarding its construction:

- Leaktightness: the quantity of stormwater able to penetrate the cap and come into contact with waste packages must be minimised. In practice, the aim is to limit the quantity to a few litres per square metre per year.
- Protection: packages must remain covered for as long as possible.

These criteria led to the implementation of a "multilayer" cap featuring alternating layers of contrasting permeability. One of these layers consists of a synthetic material called a geomembrane*, chosen for its elasticity and ability to accommodate ground movements. This material was dipped in bitumen to make it leaktight, then placed between several layers of sand. The cap is structured in the shape of a “factory roof”.



It is monitored (for settlement and ground movements) and will be maintained (and where appropriate, repaired) for as long as deemed necessary.

Laying a strip of geomembrane. Strips are welded together.

MORE INFO

The cap over the Manche disposal facility consists of layers of contrasting permeability to provide sealing, drainage and stability. It is structured in the shape of a factory roof. Its thickness varies between locations, ranging from 3 to 8 m.

It includes, from bottom to top:

- A subgrade of shale and sandstone materials that gives the cap a basic sloping shape while also serving as a buffer mat ranging in thickness from 0.5 to 8.60 m
- A 0.20 m thick drainage layer of fine sand; this layer serves as a puncture-resistant support for the geomembrane, and will collect infiltration water in the event of membrane failure. Within this layer, there are drains positioned at low points to collect any water that passes through the geomembrane,
- A bituminous geomembrane (bitumen-impregnated geotextile) about 5 mm thick, which seals the multilayer complex
- A 0.20 to 0.30 m thick sand drainage layer, separating the geomembrane from the materials of the biological barrier. This layer collects water that infiltrates through the biological barrier. Within this layer, there are drains positioned at low points to collect the water drained by the sand layer,
- A biological barrier made of compacted coarse materials, with a thickness ranging from 0.75 m at the top to 1.25 m at its lowest point. This layer is designed to protect the geomembrane against root growth and burrowing animals,
- A 0.20 m thick layer of grassed topsoil intended to prevent drying and cracking of the underlying layers, reduce gullying and mechanical erosion, and direct runoff to a stormwater collection system.

4 WASTE INVENTORY - RADIONUCLIDES AND CHEMICAL TOXICS

The waste at the Manche disposal facility contains substances that are harmful due to their radioactivity and/or their chemical nature. This chapter presents an inventory of these substances.

RADIONUCLIDES

The table on the next page shows the inventory of radionuclides disposed of at the Manche disposal facility. The table shows the overall inventory. Readers seeking more detailed information (concerning changes to the inventory over time, or its distribution among the various disposal structures, for example) may consult an additional inventory thematic sheet.

Inventory of the main radionuclides in 1994

The following table shows the total inventory, across all structures, of the main radionuclides contained in the waste disposed of at the Manche disposal facility.

The activity of radionuclides is measured in Becquerels. Values are stated below in GBq (10^9 Bq). Radioactivity decays naturally over time. The following information is shown for each radionuclide:*

- *The corresponding chemical element (e.g. caesium)*
- *The radionuclide (e.g. ^{137}Cs)*
- *The radioactive period, in years (in our example 3.00E+01, i.e. 30 years)*
- *The principal form of radiation emitted (in this case, beta radiation)*
- *The total activity at the disposal facility as of 30/06/1994 (in our example 1.13E+07, i.e. 11.3 million Becquerels).*

The inventory was calculated when the last package was received, in June 1994.

Information relating to all packages disposed of at the site is compiled in the "COCAS-RP2" computer database, which Andra intends to maintain for as long as it continues to operate disposal facilities.

DID YOU KNOW?

The stability of an atom's nucleus depends on the number of protons and neutrons it contains and their state of equilibrium within that nucleus. Radioactivity is the process whereby a nucleus, known as a radionuclide, approaches the stable zone. The heaviest radionuclides (especially alpha particle-emitting radionuclides) undergo multiple disintegrations until a stable nucleus is obtained. These cascading disintegrations temporarily increase the inventory of certain radionuclides present in the decay chain. This applies, for example, to americium 241, of which the quantity present at the disposal facility was initially small but will increase over the coming few centuries as ^{241}Pu decays, before declining again. This phenomenon is not observed for nuclei lighter than lead. Their quantity at a given date can then be calculated directly from the initial quantity and the radioactive period.

Elements	Radionuclides	Radioactive period (years)	Main radiation			Total activity at site (GBq) as of 30/06/1994
			alpha	beta	gamma	
Hydrogen	^{3}H	1.23E+01		■		1.27E+06
Beryllium	^{10}Be	1.60E+06		■		1.39E+00
Carbon	^{14}C	5.70E+03		■		2.77E+05
Chlorine	^{36}Cl	3.01E+05		■		2.60E+03
Calcium	^{41}Ca	1.03E+05		■	■	3.46E+01
Nickel	^{59}Ni	7.60E+04		■	■	4.35E+04
Cobalt	^{60}Co	5.27E+00			■	1.49E+07
Nickel	^{63}Ni	1.01E+02		■		5.42E+06
Selenium	^{79}Se	3.77E+05		■		2.77E+01
Strontium	^{90}Sr	2.88E+01		■		2.59E+06
Molybdenum	^{93}Mo	4.00E+03		■	■	6.91E+00
Zirconium	^{93}Zr	1.53E+06		■		3.50E+02
Niobium	^{94}Nb	2.00E+04		■	■	2.40E+03
Technetium	^{99}Tc	2.14E+05		■		1.75E+03
Palladium	^{107}Pd	6.50E+06		■		1.57E+01
Silver	^{108m}Ag	4.18E+02			■	6.93E+03
Tin	^{121m}Sn	5.50E+01		■		1.39E+02
Tin	^{126}Sn	2.30E+05		■		6.24E+01
Iodine	^{129}I	1.61E+07		■	■	4.27E+00
Caesium	^{135}Cs	2.30E+06		■		3.68E+02
Caesium	^{137}Cs	3.00E+01		■		1.13E+07
Samarium	^{151}Sm	9.00E+01		■		6.35E+04
Radium	^{226}Ra	1.60E+03	■			9.08E+03
Radium	^{228}Ra	5.75E+00		■		3.23E+04
Thorium	^{232}Th	1.41E+10	■			1.11E+03
Uranium	^{232}U	6.98E+01	■			9.94E+01
Uranium	^{233}U	1.59E+05	■			5.35E+00
Uranium	^{234}U	2.46E+05	■			3.31E+03
Uranium	^{235}U	7.04E+08	■			2.61E+02
Uranium	^{236}U	2.37E+07	■			1.04E+01
Uranium	^{238}U	4.47E+09	■			3.25E+03
Neptunium	^{237}Np	2.14E+06	■			1.20E+02
Plutonium	^{238}Pu	8.77E+01	■			9.11E+04
Plutonium	^{239}Pu	2.41E+04	■			2.17E+05
Plutonium	^{240}Pu	6.56E+03	■			4.42E+04
Plutonium	^{241}Pu	1.43E+01		■		1.06E+07
Plutonium	^{242}Pu	3.74E+05	■			1.24E+02
Americium	^{241}Am	4.33E+02	■			3.80E+04
Americium	^{243}Am	7.36E+03	■			2.66E+02
Curium	^{242}Cm	4.46E-01	■			8.48E+02
Curium	^{243}Cm	3.00E+01	■			2.55E+01
Curium	^{244}Cm	1.80E+01	■			2.15E+04

Total disposal inventory at the CSM, as assessed in June 1994 (on reception of the last waste package). The radioactive period and main type of radiation (alpha in yellow, beta in green and gamma in red) are shown for each radionuclide.

CHEMICAL TOXICS

The radioactive waste disposed of at the Manche disposal facility also contains toxic chemical elements. These elements were not subject to the same reporting requirements as radionuclides on delivery of the packages. Andra nevertheless established a retrospective inventory, based on a survey of waste producers in 1996, after receiving the final waste package.
It is important to note that, unlike radioactivity, chemical toxicity does not decrease over time. As a result, the disposal inventory shown in the table below will remain constant over time.

Total inventory of chemical toxics	
Chemical toxic	**Mass (kg)**
B	222049
Be	8
Cd	15300
Cr	2025
Hg	879
Ni	21666
Pb	17418302
$PbSO_4$	2296526
U	264284

DID YOU KNOW?

Use of lead to protect workers

Lead is the most prevalent of the toxic elements identified in waste at the Manche disposal facility; this is because lead screens were commonly used for radiation protection in the nuclear power industry.*

Lead screens were placed around the most highly irradiating waste (containing ^{60}Co and ^{137}Cs in particular) to protect workers from gamma radiation emitted by such packages during disposal operations.

5 SITE MONITORING AND EVOLUTION

In 2003, after several years of administrative procedures, the Manche disposal facility entered a new phase of its life cycle, to prepare for its permanent closure and monitor its evolution to check that any chemical and radiological impacts on local residents and their environment remain very low. The main activities during this phase include:

- **Monitoring of the disposal facility and its environmental impact;**
- **Effluent management;**
- **Studies to gradually close the facility and to check that its operation is sufficiently passive to allow monitoring operations to be scaled down over time. The ultimate goal is for the site to evolve naturally without human intervention, and more specifically, with no need for an operator to remain present onsite.**

ANDRA conducts a safety review of the disposal facility every ten years, to ensure that its impact remains acceptable for people and the environment, on the basis of the applicable criteria. These regular reviews incorporate monitoring feedback.

Current situation: low impact and effective monitoring

At the end of the operating phase, in around 1994, the facility's waste package reception and placement installations were dismantled and the disposal area covered with a cap designed to limit water infiltration, as described in Chapter 3. The water management systems were adapted and the legacy basins redeveloped and converted into a monitoring building. This building, known as the "basin building", is located at the northwest corner of the disposal facility and is currently in service. It backs onto the cap, which also shelters its roof.

MORE INFO

How is the radiological impact assessed?

The radiological impact is assessed based on the level of radioactivity in emissions from the facility, using a human transfer model.

<u>How is the level of radioactivity in emissions determined?</u>
While the operator is on site, the level of radioactivity in emissions is measured: In the current configuration, emissions are distributed as follows:

- In stream water: surface water discharged from the facility flows into the Sainte-Hélène stream. However, the Grand Bel stream (a tributary of the Sainte-Hélène) and the Roteures stream (further east) also receive groundwater inflows influenced by the disposal facility.
- In seawater (for at-risk effluents discharged into the sea after being transferred to the neighbouring Orano industrial treatment plant). The impact on seawater is extremely limited, due to the powerful dilution effect.

Future impact assessments are based on emissions calculated by modelling.

The impact of the emissions into the Sainte-Hélène stream is greatest for individuals in the simulated group of farmers in the hamlet of La Fosse in Digulleville. Their annual dose received was calculated by combining the doses respectively due to soil inhalation and to internal exposure resulting from their diet, which is assumed to contain high proportions of locally-sourced plant and animal produce, as well as beverages made from the Sainte-Hélène stream.

In January 2003, the CSM received approval to enter a new phase devoted to preparing for the transition to the monitoring phase. Today, the activity of the facility's operator, Andra, consists in monitoring the air and water, as well as in the cap and its vegetation. This monitoring is accomplished, in particular, by inspecting effluent before it is released into the environment, and by analysing samples collected from the environment and tracking any changes in sensor readings. This monitoring makes it possible to track the disposal facility's evolution, check that its behaviour is as predicted and ensure that its environmental impact remains very low.

In 2017, the radiological impact of releases from the CSM was estimated at 0.00020 mSv/year (for an adult), on the basis of the activity measured in the Sainte-Hélène stream, for farmers whose lifestyle, diet and drinking habits would leave them most exposed to contamination. This impact, which is far lower than that of natural radioactivity and well within the annual dose limit of 1 mSv for the general public, is not significant. The radiological impact of discharges into the sea is even lower: of the order of 10,000 times less.

Outlook

The Manche disposal facility (CSM) is designed to provide effective protection against chemical and radiological risks associated with the waste. This protection will be effective provided no inappropriate anthropic activities disturb the site. As long as the site continues to be actively monitored and its facilities maintained, the risk of human disturbance is extremely limited.

- ### Normal evolution of the disposal facility

The "normal" evolution of the CSM corresponds to the predicted (or most probable) evolution of the safety provisions (i.e. waste packages, disposal structures and cap).

The studies carried out make it possible to conclude that the only way radioactive substances can be dispersed outside the waste packages is via stormwater infiltrating through the cap, a fraction of which might reach the groundwater and ultimately the nearby Sainte-Hélène and Grand Bel streams (and possibly the Roteures) over longer timescales, when the cap has lost its sealing properties.

In the long term, the CSM's impact on its environment will remain very low.

MORE INFO

What impact can be expected for the most exposed local residents?

In the normal scenario, long-term calculations were carried out for farmers, who were assumed to exclusively use water from the Sainte-Hélène stream for drinking and for irrigating the vegetable crops they eat.

Based on those calculations, the dose received should be less than 1 mSv/year. In the light of these forecasts, the use of the river's water by future generations should not pose a health problem attributable to the Manche disposal facility.

Drinking this water is nevertheless not recommended, due to its poor physicochemical quality (see page 9).

Risks

Despite the measures adopted to protect people and the environment against the harmful effects of the waste present at the Manche disposal facility, it is important to identify any risk situations that could lead to people nevertheless being exposed to radioactive or chemical effects caused by waste at the site. This is the principle behind the Safety Assessment.

The biggest risk is considered to involve an individual coming into contact with radioactive waste, whether by direct exposure or inhalation of dust. Another risk relates to the presence of radionuclides or chemical toxics in water near the site, at levels above the regulatory health limits for drinking water. These two types of risk might materialise in particular in the event of abnormal deterioration of the disposal facility (and especially the cap, as a result of subsidence, erosion affecting the roof, or landslips affecting embankments along the edge of the facility, etc.). This could uncover waste packages, some of which might be torn open, potentially allowing their contents to come into contact with rainwater or a passing rambler. These risks could also materialise as a result of inappropriate human actions.

IN BRIEF

What does a safety assessment involve?
The safety of the Manche disposal facility is regularly analysed by assessing the impact of various scenarios on humans and the environment:

- normal evolution scenarios: the disposal facility evolves as planned
- altered evolution scenarios: the disposal facility departs from the predicted evolutionary path for some reason, such as failed containment barriers, natural risks, human intrusion, etc.

The Safety Assessment is updated every 10 years.

The health impact of the various scenarios has been assessed. Exposure related to the uncovering of waste packages would appear to present the greatest risk, as the corresponding radioactivity doses (a few tens of millisieverts) are above the regulatory limits for the general public, while remaining of the order of magnitude permissible for workers exposed to ionising radiation. These potentially significant impacts are essentially associated with older waste packages containing long-lived radionuclides.

DID YOU KNOW?

As part of the studies carried out before waste packages were brought to the facility, scenarios simulating the construction of infrastructure (roadworks, residential area, children's playground, etc.) on the site of the disposal facility after 2360 AD (i.e. after the departure of the operator) were analysed. These studies found the impacts of such scenarios to be acceptable.

In any case, human intrusion onto the site should be avoided. This document is part of the memory preservation measures adopted to that end.

MORE INFO

What would be the impact for a rambler coming into contact with waste after the monitoring phase?

Of the studied scenarios, the worst case involves contact with uncovered waste. In this scenario, the condition of the disposal facility is assumed to have deteriorated (via damage to the cap, for example, potentially resulting in erosion or slippage of an earth bank, tearing the bituminous membrane) uncovering a number of waste packages, some of which may be torn open. It is assumed that someone (for example, a rambler) may approach or come into contact with the waste packages. This would potentially expose the rambler to health effects, which would depend on:

- the nature of the waste packages:
  - ✓ physical condition: intact or torn open;
  - ✓ radiological characteristics: type of radionuclides and activity (determined by their decay);
  - ✓ characteristics in terms of chemical toxics associated with nuclear waste;
- the mode of exposure of the person near the package(s):
  - ✓ ingestion and inhalation of dust from the package;
  - ✓ external exposure to ionising radiation emitted by the package(s).

The assessments focus on waste packages containing the highest activities by long-lived alpha-emitting radionuclides held in disposal structures near the surface or perimeter of the facility.

In these assessments, two scenarios were considered regarding the physical condition of the packages:

- ✓ <u>Scenario 1: The packages are intact</u> - *In this case the impact is from external exposure to radiation.*
  The assessment results pointed to a health impact of less than 1 mSv, except for a batch of 35 waste packages disposed of in structure P17 in 1982 (which yielded an impact of 35 mSv, due to their ^{232}Th content). The estimated results included margins.
- ✓ <u>Scenario 2: The packages are torn open</u> - *In this case, the impact results from exposure via the ingestion and/or inhalation pathways and contamination of the skin of the hands and face, as well as external exposure to radiation*).
  The assessment results show that the highest impacts would be of the order of several tens of mSv. These impacts were calculated conservatively assuming that the individual is not only exposed to ionizing radiation, but also inhales and ingests dust from the package. The impact would be largely due to ^{239}Pu, via the "inhalation" pathway.
  These results show that, for future generations, avoiding unintentional contact with gutted waste packages is a prudent precaution.

Note: In these two scenarios, the rambler is assumed to remain at a distance of one metre from the package for a period of three hours.

DID YOU KNOW?

French regulations define a maximum limit for exposure to radioactive radiation resulting from human activities. This limit is 1 millisievert* (mSv) per year for the general public (this dose is in addition to natural radioactivity and any doses received during medical procedures), and 20 mSv for workers in an ionizing environment.

In metropolitan France, an individual's average exposure to natural radioactivity represents a dose of about 2.9 mSv per year.

6 LONG-TERM MEMORY OF THE MANCHE DISPOSAL FACILITY

This document is intended to be distributed widely, primarily to the local population and its representatives (elected officials, NGOs, etc.). It aims to provide essential information that will avoid human intrusion into the Manche disposal facility. It is an important component of the regulatory memory preservation measures adopted for the Manche disposal facility.

This document is a Key Information File ("KIF"), produced in accordance with the recommendations issued by the expert group for the “Records, Knowledge & Memory preservation across generations” (RK&M) project carried out under the aegis of the OECD Nuclear Energy Agency, from 2011 to 2018. According to the French regulations in force on the date of publication[2], a Summary Memory File (DSM) and a Detailed Memory File must be produced for every basic nuclear installation involved in radioactive waste disposal. This document is one part of the DSM. The other parts are:

- A very concise one- or two-page Leaflet, which is part of the DSM but can also be distributed more widely;
- Thematic Sheets addressing issues of interest to readers.

The Summary Memory File is intended to be distributed widely (locally, at town halls, land registries, notarial offices, etc.; and regionally, at departmental archives), with the aim of preserving the memory of the site for as long as possible. The current version of the DSM is considered to be a "preliminary" form by current regulations. It is subject to change, and its final form will be determined at the time of the license application regarding the facility’s closure and transition to the monitoring phase.

The Detailed Memory File is intended, for as long as an organization responsible for the Manche disposal facility is present on site, to provide managers with comprehensive information to aid decision-making relating to the site. At least two copies of this set of documents are archived, one of which at the National Archives. This is a regulatory requirement for closure and transition to the monitoring phase.

Andra intends to regularly update the memory files in the light of experience feedback, until the end of the monitoring phase.

[2] The Summary Memory File (DSM) and the Detailed Memory File are required by Article 42 of Decree 2007-1557 of 2 November 2007, amended by Decree No.2016-846 of 28 June 2016.

7 RADIOACTIVE WASTE DISPOSAL FACILITIES WORLDWIDE

All countries that use radioactivity - whether for power generation or in medicine, research or industrial activities - must address the issue of managing the waste generated by such activities. Multiple types of radioactive waste disposal therefore exist around the world, at various stages of their life cycle. Some are in the planning stages, others are receiving waste, and yet others have stopped accepting waste but are being monitored. This chapter presents a non-exhaustive list of low- and intermediate-level waste disposal facilities. The aim is to make an initial contribution to the development of a network of key information documents (KIF) in a unified format, to help preserve the memory of all disposal facilities of the same type. Future versions of this chapter are expected to evolve significantly.

In France

Aube disposal facility (CSA)
This surface disposal facility is located in the municipality of Soulaines-Dhuys, 60 km east of Troyes in the Aube department. It has accommodated short-lived low-and intermediate level waste since 1992. This facility has taken over the role of the Manche disposal facility (CSM).
Waste is held in concrete disposal structures. At the date of publication, approximately 300,000 m^3 of waste had been sent to the site, which has a total capacity of 1,000,000 m^3. The facility is forecast to be full by 2070. At the end of its operating phase, the facility will be covered with a multilayer cap. The long-term behaviour of the cap is already the subject of research on an experimental cap.

Industrial Facility for Nuclear Waste Collection, Storage and Disposal (Cires)
Cires is a surface disposal facility located near the municipality of Morvilliers in the Aube department, 50 km east of Troyes and a few kilometres from the Aube disposal facility. It has been receiving very low-level waste since 2003.
The waste is disposed of in cells dug into the clay. At the date of publication, approximately 350,000 m^3 of waste has been received at the site, which has a total capacity of 650,000 m^3. The end of the operating phase is planned for 2025-2030.

In the United Kingdom

1. Low Level Waste Repository
The LLWR is a surface disposal facility located near Sellafield, in the county of Cumbria in north-west England. It is the UK's national disposal facility for low-level waste. It has been in service for more than 50 years.
The LLWR receives low-level solid waste from various customers, including the nuclear industry, the Ministry of Defence, non-nuclear industries and educational, medical and research institutions. Most of the waste, typically paper, card, plastic, protective clothing, soil, rubble, and metal, arrives at the site in large metal containers. The low-level waste is then injected into containers and placed in concrete disposal structures.
The site is currently scheduled for closure in 2130. A permanent cap will be built over the concrete disposal structures and the seven landfill-type trenches in which waste was disposed of prior to 1988.

2. Low Level Waste Vault Facility (Dounreay)

The Dounreay disposal facility is located in the county of Caithness, Scotland. It will generate up to 175,000 cubic metres of low-level solid waste from decommissioning activities. Low-level solid waste includes metal and concrete, glass, contaminated soil and other materials, such as polyethylene sheeting, plastic gloves and paper, that are lightly contaminated with radioactivity.

The construction of two hazardous waste disposal facilities in Dounreay, including an encapsulation plant, was completed in September 2014. The disposal structures are located immediately north-east of the Dounreay nuclear site. The facilities are intended for disposal of low-level waste generated at Dounreay and the adjacent Vulcan site only. The encapsulation plant was constructed to fill the low-level waste containers with a cement-based grout prior to disposal at the facility.

DSRL, the company tasked with managing the site, has holds licences for a total of six concrete disposal structures built in shallow excavations. Once the structures have been filled, they will be closed and the residual excavated voids around them back-filled. The roof of the structures will be removed, the upper part will be provided with an engineered cap and the area restored to the fullest extent possible, using appropriate landscaping to blend into its original environment.

<u>In Sweden</u>

The final repository for short-lived radioactive waste (SFR)

SFR is located in Forsmark in the municipality of Östhammar, in north-east Uppland in Sweden. The centre is approximately 80 km from Gävle, 80 km from Uppsala and 150 km from Stockholm. The facility, which began operating in 1988, is located around 60 m below the Baltic Sea bed. It comprises four 160-metre-long rock vaults and a silo in the parent rock containing a 50 m high concrete silo for the most highly radioactive waste. Low- and intermediate-level radioactive waste from Swedish nuclear power plants accounts for much of the waste sent for disposal at the SFR. This includes filters that have trapped radioactive substances present in reactor coolant, as well as tools and protective clothing. The facility also accepts radioactive waste from hospitals, veterinary medicine, research and industry.

There are plans (2018) to extend the facility with six additional vault structures in the rock (one 240 m long vault and five 275 m vaults), in order to accommodate waste generated by dismantling Swedish nuclear power plants. The new vaults will be located around 120 m below the sea bed. The existing SFR has space for approximately 63,000 cubic metres of waste. When fully deployed, the facility will have a capacity of approximately 200,000 cubic metres.

SFR will enter its shutdown and closure phase until the mid-2070s.

<u>In the USA:</u>

Waste Isolation Pilot Plant (WIPP)

This deep salt disposal facility is located in the Chihuahuan Desert, near the city of Carlsbad in south-east New Mexico. It has been accepting low- and intermediate-level waste of military origin, including a significant proportion of transuranic (TRU) waste, since 1999. This radioactive waste disposal facility is excavated into salt domes more than 650 metres underground. The facility is still in operation.

Disposal operations are expected to continue beyond 2050. Shutdown and closure of the site will be followed by a monitoring period.

APPENDIX: GLOSSARY

This glossary explains terms marked with an asterisk whenever they appear in a chapter of this document.

Activity	Intensity of the radioactive radiation emitted by an element. Activity is measured in Becquerels*. Depending on its intensity, activity may be described as low (or very low), intermediate or high. The Manche disposal facility hosts only low- and intermediate-level waste.
Alpha	See "alpha ray"
Alpha ray	Alpha rays are a form of radiation emitted by highly radioactive particles. Alpha rays have very limited penetrating power and are blocked by even a sheet of paper, but they are often longer-lived than beta and gamma rays.
Areva	Private company with a division that operates a reprocessing plant in the immediate vicinity of the Manche disposal facility (see Orano).
Becquerel (Bq)	Unit of measurement for radioactivity. One Becquerel corresponds to one atomic disintegration per second. 1 GBq (Gigabecquerel) = 10^9 Bq 1 TBq (TeraBecquerel) = 10^{12} Bq
Beta ray	Another form of radiation emitted by radioactive particles. Beta rays can be blocked by a sheet of aluminium or a window.
CEA	The French Alternative Energies and Atomic Energy Commission (CEA) is a public scientific research organization specialising in energy, defence, information technologies, material sciences, life sciences and health, with facilities at ten sites in France. Originally named the French Atomic Energy Commission (CEA) in 1945, it changed its name in 2010 as it expanded its operating scope to include alternative energies.
CSM	Acronym of *Centre de Stockage de la Manche*, i.e. the Manche disposal facility
Gamma ray	Gamma rays are a form of high-energy, non-visible light radiation. They have greater penetrating power than alpha and beta radiation but a lower intensity.
Geomembrane	Synthetic material performing a sealing function
Half-life	(see "Radioactive period")
Isotope	Version of an atom that differs slightly in the composition of its nucleus. Some isotopes are 'unstable', which makes them radioactive. Such isotopes are known as radionuclides.
Monolith	Disposal structure into which packages are placed in reinforced concrete cells, filling the gaps with concrete.

Orano French multinational energy company, operating principally in the nuclear industry. Orano operates the spent fuel reprocessing plant in La Hague, adjacent to the Manche disposal facility. The name Orano was adopted in 2018, in the context of an industrial restructuring operation. The company in charge of this facility was formerly known as AREVA.

Package Conditioned and packaged radioactive waste

Radioactive period Period of time required for half of the atoms in a radioactive isotope* (aka radionuclide*) to naturally decay.

Radioactive tracing Detection of a radionuclide in a quantity of water.

Radionuclide Radioactive isotope* of a chemical element. A radionuclide is an unstable atom, meaning that it spontaneously disintegrates (or decays). Radionuclides emit radiation as they decay.

Radiation protection Radiation protection is the set of rules, procedures and means of prevention and monitoring aimed at preventing or reducing the harmful effects of ionising radiation on people and the environment, either directly or indirectly.

Sandstone Type of rock formed by the aggregation of grains of sand

Shale Type of rock with a tendency to split into thin plates.

Sievert (Sv) Unit used to quantify the impact of radioactive radiation on humans. Sub-multiples of this unit are commonly used:
- 1 mSv (millisievert) = 10^{-3} Sv
- 1 µSv (microsievert) = 10^{-6} Sv

The regulatory limit in force at the time of writing stipulates that the sum of the doses of radioactivity received by a member of the public must not exceed 1 mSv/year, excluding medical and natural exposure.

Sealed source A radioactive source structured or packed such that no dispersion of radioactive materials into the surrounding environment occurs under normal conditions.

Tumulus Disposal structure consisting of stacked waste packages, with gravel filling the gaps between them.

RÉPUBLIQUE FRANÇAISE
Liberté
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ANDRA
Agence nationale pour la gestion des déchets radioactifs

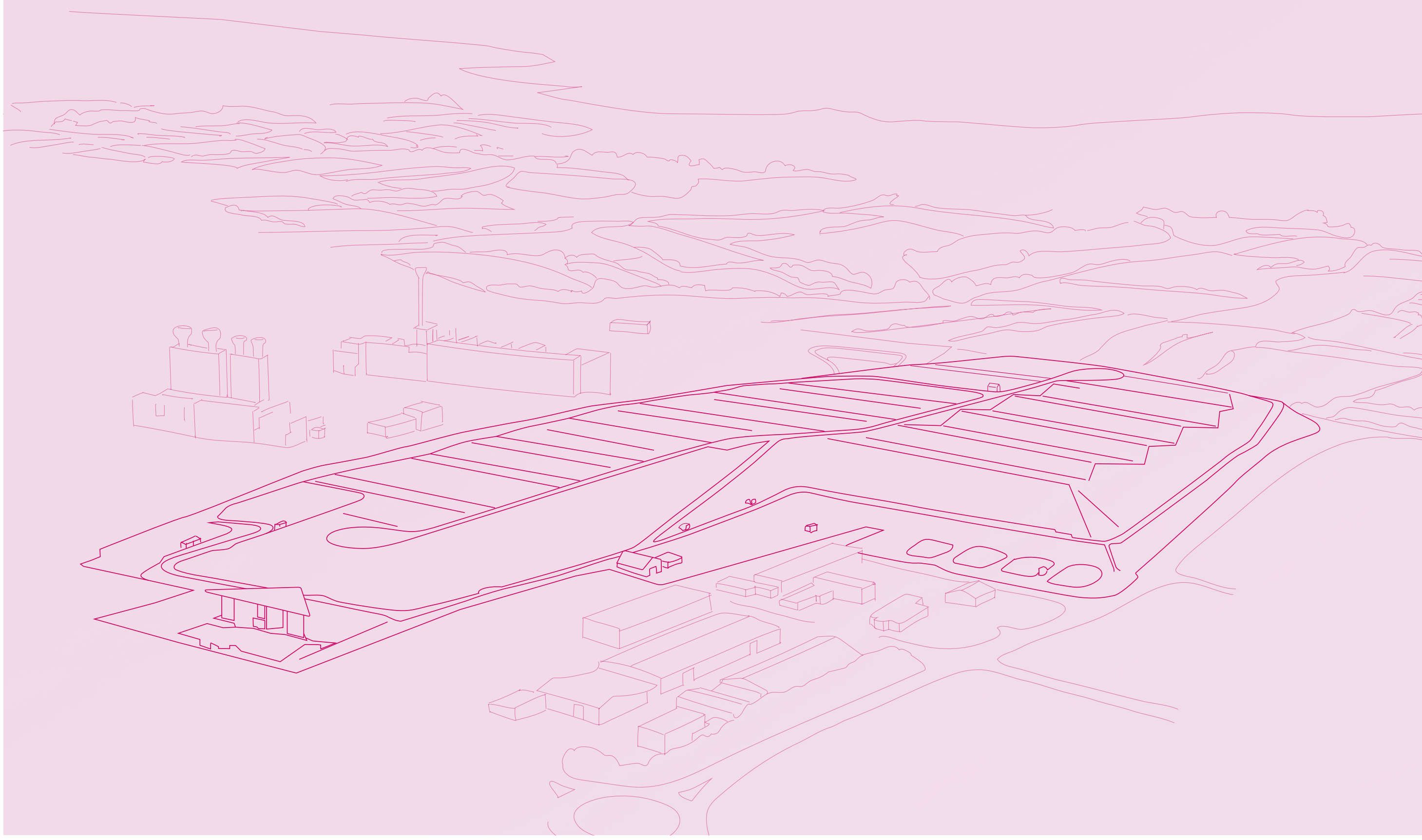
2019 version

Summary Memory File
Manche Disposal Facility

Thematic Sheets

Memory of the Manche disposal facility

A set of Thematic Sheets forms one of the three constituent documents of the Summary Memory File, which also includes the Leaflet and the Key Information File



"HISTORY OF THE MANCHE DISPOSAL FACILITY"

From 1965 to the present day (2018)

1 Introduction

This "Thematic Sheet" has been produced by Andra, the operator of the Manche disposal facility (Centre de Stockage de la Manche - CSM), to present the history of this radioactive waste disposal facility (classified as "basic nuclear installation no. 66") for future generations.

The Manche disposal facility (CSM), located at the tip of the Cotentin peninsula, some 20 km northwest of Cherbourg-Octeville in the La Hague municipality (specifically, the delegated municipality of Digulleville), was France's first industrial surface disposal facility for low- and intermediate-level radioactive waste (LILW).

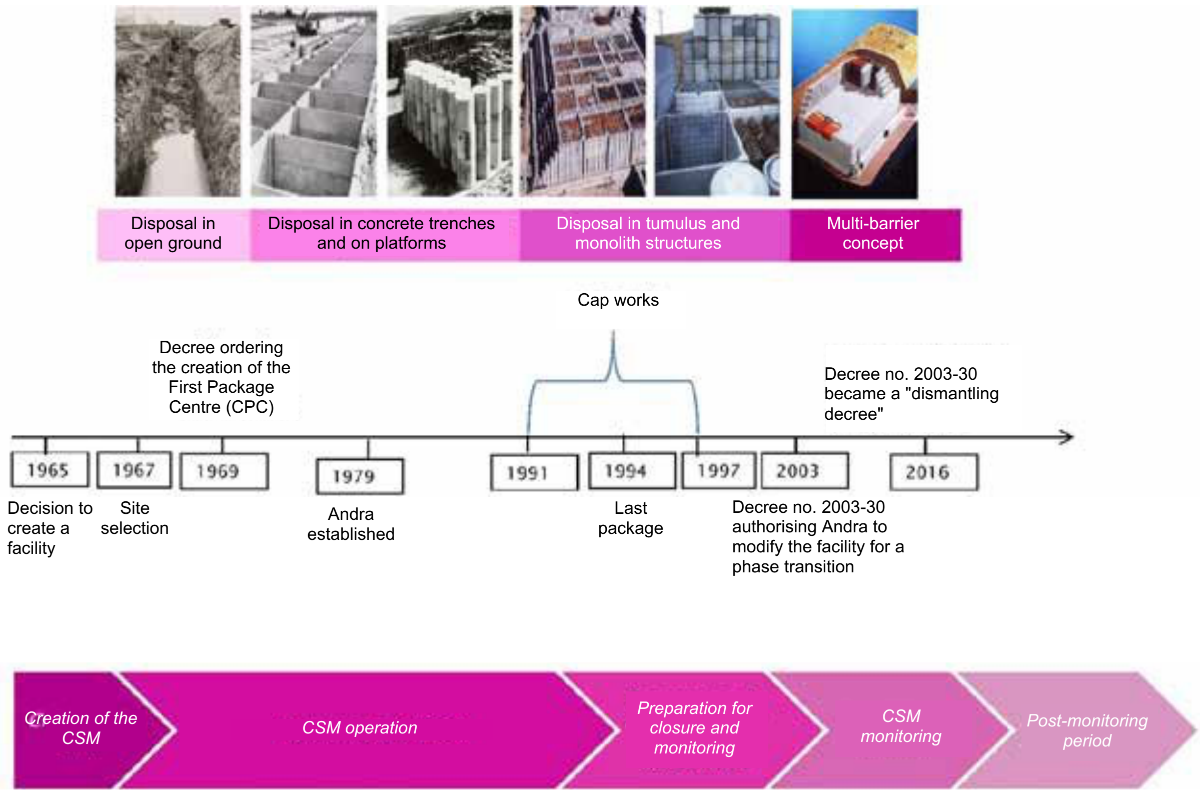
It operated for 25 years, from 1969, when the first package was delivered, until 1994, when the last package was received.

This facility marked a first in the history of surface disposal of radioactive waste in France. It was the culmination of 25 years of work (receiving and disposing of waste packages) during which the long-term management of this waste became an activity in its own right. Analyses were carried out, the regulatory framework has gradually been enriched, and specific techniques have been implemented to support the development of this activity. The considerable experience acquired at the Manche disposal facility benefited the Aube disposal facility (in the commune of Soulaines-Dhuys), which took over its role in 1994.

Key figures

- First radioactive waste disposal facility in France
- 25-year operating phase
- Monitoring of the disposal facility and anticipated environmental impacts for approximately 300 years
- 14.78 hectares occupied by the CSM
- 527,225 m^3 of radioactive waste
- 1,469,265 packages received
- GPS coordinates: Latitude: 49.67° N, longitude: 1.86° West

2 Timeline



- The history of the CSM is divided into four main periods:
  - ✓ Creation of the facility, from 1965 to 1969
  - ✓ Operation, from 1969 to 1994 (waste package reception and disposal period)
  - ✓ Preparation for closure and transition to the monitoring phase:

    - 1991 – 1997: installation of the protective cap

    - 2003: publication of Decree no.2003-30 granting Andra permission to modify the Manche disposal facility in preparation for transition to the monitoring phase. This decree requires the operator to monitor the disposal facility and its environmental impact, and to assess the benefits of a more permanent cap.

    - In 2016, Decree no. 2003-30 became a "dismantling decree" and the French Nuclear Safety Authority, which is in charge of monitoring the facility, asked Andra to state its position regarding, firstly, the timeframe for filing the licence application relating to its closure and transition to the monitoring phase, and secondly, the duration of the monitoring phase.
  - ✓ .... Looking ahead...

    - End of the closure phase: work to ensure that the cap is durable

    - Monitoring phase, during which the operator will maintain a presence onsite, carry out monitoring, maintenance and any necessary repairs, and gradually adapt the water management system to fully passive operation. By the end of this phase, the disposal facility is expected to no longer require any human intervention (fully passive operation, including water management)

    - Post-monitoring phase: the operator will no longer be present. Some public utility easements are nevertheless envisaged.

3 Key stages

3.1 Creation of the CSM

Following the creation of the Atomic Energy Commission (CEA) after the Second World War, nuclear research institutions began generating significant quantities of radioactive waste. The rapid pace of technological progress and successive achievements meant the CEA soon had to consider the future of the "radioactive waste" being produced and stored at its facilities. In 1967 and 1969, France took part, on a trial basis, in two international experimental immersion campaigns before giving up this practice, deemed unsatisfactory.

In 1965, France decided to create a dedicated disposal facility for this waste.

Beginning in early 1966, a company named Infratome was set up by the CEA and PEC-Engineering to conduct engineering studies to define the administrative and technical conditions for the planned disposal facility. Infratome studied several possible sites in the northern part of the Cotentin peninsula.

In 1967, the CEA, which owned more than 300 hectares of land accommodating its La Hague fuel reprocessing plant, submitted a geology and hydrogeology study covering the area and granted Infratome permission to use one of its sites, located in the municipality of Digulleville (now a delegated municipality of La Hague), in the area where the water table was furthest below the surface. The chosen site was uncultivated, unfenced land outside the perimeter of the reprocessing plant. Planning permission was granted in 1968 [1]. The land was made available to Infratome by the CEA under the terms of an agreement dated 16 October 1968. The chosen site extended over an area of 12.1377 hectares[1].

The Ministerial Decree of 19 June 1969 [2] officially commissioned the Manche disposal facility (CSM). From a regulatory perspective, the CSM was classified as a basic nuclear installation (BNI) with the designation "BNI no. 66".

3.2 First steps for the radioactive waste disposal discipline (1969-1979)

Everything had to be invented from scratch. The early years of operation were a time of continuous progress, with the operator analysing practices in detail, correcting mistakes and learning from them in order to quickly implement necessary improvements.

3.2.1 Operation by Infratome on behalf of the CEA

During this period, the facility was operated on behalf of the CEA by the subcontractor PEC-Infratome.

The general operating framework was defined by the Decree of 19 June 1969 approving the facility's creation[2]. The operating conditions of the permanent disposal facility changed in response to operating experience feedback. They were formalised in "technical specifications" stipulating requirements relating to the properties of the waste packages and the characteristics of the disposal solution.

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[1] The northern, eastern and southern parts of the plot were set back a few metres from the CEA property line. Andra subsequently purchased plots of land from COGEMA (now Orano), in order to improve the disposal facility's operating conditions, and later to allow the cap to be implemented in good technical conditions. Currently, Andra owns 14.7894 hectares of land

[2] The operation of BNI 66 involved two distinct activities:

- Permanent disposal of radioactive waste;
- "Temporary storage" of radioactive waste pending transfer to another site at a later date, using a management solution appropriate to the specific characteristics of the waste. This applied in particular to highly irradiating waste, waste containing radium-bearing lead sulphates or liquid waste.

This waste was indeed subsequently removed as part of the work to close the disposal facility and prepare the transition to the monitoring phase.

3.2.2 Changing disposal techniques

Throughout the operating phase, the operator sought to improve the disposal concept whenever possible. In particular, between 1969 and 1979:

- The open-ground trenches dug for low-level waste (generally contained in ordinary drums), which were approved by the Decree of 19 June 1969, were replaced in 1971 by asphalt platforms surrounded by a drainage network, on which the drums were arranged in batches between rows of packages packed in concrete blocks. A gentle slope allowed runoff water to flow away. The 4 to 5 m high arrangement was covered with clayey soil followed by grassed topsoil, forming an approximately 1 m thick cap;
- The concrete trenches, initially made up of prefabricated elements, were replaced by 1977 with bituminous concrete monoliths that had drains at the base and were covered with a concrete slab.

This period from 1969–1979 can be considered experimental, with regard to disposal techniques.

3.3 1979: Creation of Andra, the National Radioactive Waste Management Agency, to oversee this maturing industrial activity

The government asked the CEA to set up an internal entity to take direct responsibility for management of all this waste. Accordingly, the French national radioactive waste management agency (Andra) was established in 1979. At that time, Andra was a division of the CEA.

The first task assigned to Andra was to develop the surface disposal system for low- and intermediate-level waste. The agency took over the operation of the Manche disposal facility. It quickly introduced some basic rules to ensure safe, streamlined disposal. For example, waste had to be packed in standardised packages. In addition, Andra built a collection system to test and control water leaving the disposal facility, making it possible to monitor the CSM's environmental impact.

3.4 1984–1986: Introduction of new requirements by the central service for safety of nuclear installations, SCSIN

The period from 1984 to 1986 was an important milestone in the disposal facility's operation, with the publication of the Basic Safety Rules (RFS I.2 [3] and RFS III.2.e [4]) as well as the technical requirements issued by SCSIN (which would later become the Nuclear Safety Authority, ASN). Further to these publications, the operation of the disposal facility shifted towards a design that gave even greater consideration to aspects such as the containment properties of waste packages, protecting structures against water, ensuring the long-term stability of the disposal facility, and effective information archival.

This was an important period in the operation of the disposal facility, which entered an "industrial" phase featuring so-called "tumuluses" (featuring stacked packages, with a filling material plugging the gaps between them) and "monoliths" (monolithic concreted structures).

3.5 1991: Andra becomes independent from the CEA

Law No.91-1381 of 30 December 1991 [5] relating to research on radioactive waste management granted Andra the status of a public industrial and commercial undertaking (EPIC) reporting to the ministers for industry, research and the environment. This legislation made Andra independent of the CEA (and hence from the producers of radioactive waste). Following this change, the Decree of 24 March 1995[3] formally transferred the operation of the Manche disposal facility from the CEA to Andra (in its capacity as an EPIC).

[3] Decree of 24 March 1995, authorising the French National Radioactive Waste Management Agency to operate the Manche radioactive waste disposal facility, included in the legislative texts available for consultation.

3.6 Closure of the disposal facility and preparation for the transition to the monitoring phase

In 1991, Andra initiated the closure of the disposal facility and began preparing the transition from the "operating phase" to the "monitoring phase". The operator's main activity still consisted in monitoring the behaviour and environmental impact of the disposal facility (as well as carrying out any necessary maintenance and repair work). The Manche disposal facility is subject to regulatory ten-year reviews to assess the condition of the site and its impact on the environment. These reviews are recorded in a "Safety Report". At the time of writing (2019), the most recent safety report was issued in 2009. The 2009 Safety Report is referred to as "RDS 2009".

3.6.1 1991–1997: Installation of the cap and redevelopment of the water management systems

The last radioactive waste package arrived at the Manche disposal facility on 30 June 1994, bringing the operating phase to an end. By that date, some significant changes had already been made in order to prepare for the transition to the monitoring phase (including preparations for the cap works and the works to develop stormwater and drainage water collection systems at the base of the disposal structures).

Work to install a cap over the disposal facility began in 1991. This work was organised in three phases: "Phase 1" (north section), "Phase 2" (central section) and "Phase 3" (south section). Work on Phase 3 was suspended for a few months in 1996 at the request of the "Turpin Commission" (see below).

The cap works were preceded by modifications to the systems designed to collect water infiltrating the disposal structures, in order to connect them to an orbital drain system around the disposal centre that collects the outflows from these "secondary systems" and gravity-drains them to the north-west corner of the site. This water is currently routed to the Orano effluent treatment plant. This main drain lies in a concrete tunnel large enough to afford access for monitoring activities (including leak testing and measuring the collected volumes).

Decree no. 2003-30 was published on 10 January 2003 [8], authorising Andra to modify the facility in preparation for the transition to the monitoring phase. In particular, this decree instructs Andra to present "a report on the benefits of implementing a more permanent cap making it possible to passively ensure the long-term safety of the disposal facility". An initial document was prepared in 2009, followed by a second in 2015; discussions regarding the design of a permanent cap are still ongoing (as of 2019).

3.6.2 1993–2003: Iterations to prepare the regulatory files informing Decree 2003-30 of 10 January, 2003

Multiple iterations were necessary between 1993 and 1998, to prepare the regulatory files that would form the basis for the application for approval to transition to the monitoring phase [6]. In particular, at the request of the then Minister for the Environment, a commission (known as the "Turpin Commission") was set up in 1996 to assess the situation of the Manche disposal facility. This committee found that in normal operation, with active monitoring, the facility did not present a risk to the environment and the population. In December 1996, the government adopted the Turpin Commission's guidelines and requested that Andra prepare a new application to transition to the monitoring phase, taking said guidelines into account.

In 1998, therefore, Andra submitted a new application for a licence to enter the monitoring phase, accompanied by a discharge licence application. These applications were reviewed by a public inquiry in 2000. The public inquiry committee issued a favourable opinion.

Eventually, in 2003, the following documents were published:

- Decree no. 2003-30 of 10 January 2003[4], granting Andra permission to modify the Manche radioactive waste disposal facility in preparation for transition to the monitoring phase.
- The decree of 10 January 2003[5] authorising Andra to continue discharging gaseous and liquid effluents for the purpose of operating the Manche radioactive waste disposal facility;
- The technical requirements for the monitoring phase of BNI 66 [7]

3.6.3 2016 – Regulatory change leading to acknowledgement that the CSM is in the "closure" phase

Following the publication of Decree no. 2016-846 of 28 June 2016, Decree no. 2003-30 was "equivalent to a dismantling decree" and the CSM entered a so-called "closure phase" (between the "operating phase" and the "monitoring phase"). From a regulatory perspective, the "monitoring phase" is deemed to begin when the disposal facility is considered permanently closed. This implies that the cap be considered sufficiently durable by the French Nuclear Safety Authority (ASN).

4 Bibliography and link to the Detailed Memory File for more information:

Readers seeking more information may consult the Detailed Memory File (DDM) for the CSM. Copies of the DDM are currently kept in two separate locations: at the CSM and in the National Archives of France.

The DDM is a corpus of documents, classified in a filing system structured chronologically and then thematically.

[1] Planning consent no. 24.341, granted on 9 July 1968 by the Ministry of Infrastructure and Housing

[2] Decree of 19 June 1969 authorising the Atomic Energy Commission (CEA) to modify installations at the La Hague centre by creating a solid radioactive waste disposal facility.

[3] Basic Safety Rule (RFS) No. I.2 relating to safety objectives and design bases for surface facilities intended for the long-term disposal of short- or medium-lived, low- or intermediate-level solid radioactive waste. 1984 edition

[4] Basic Safety Rule (RFS) No.III.2.e relating to preconditions for approval of packages of encapsulated solid waste intended for surface disposal – Appended to SIN Paris letter no. 3948/86 of 31 October 1986.

[5] Law no. 91-1381 of 30 December 1991, on research into radioactive waste management (included in the legislative texts available for consultation).

[6] Manche disposal facility (CSM) Application for approval to transition to the monitoring phase ANDRA SG/AJ/HG/SLR/DIR.391

[7] Technical requirements for the monitoring phase of the radioactive waste disposal facility known as the Manche disposal facility (BNI no. 66) – Appended to letter ASN/DGSNR/SD3/0066/2003 of 3 February 2003

[4] Decree no. 2003-30 of 10 January 2003, authorising the French National Radioactive Waste Management Agency (ANDRA) to modify the Manche radioactive waste disposal facility (basic nuclear installation no. 66), located in the municipality of Digulleville in the Manche department, in preparation for transition to the monitoring phase. This decree was considered a dismantling decree, as per Article 15 of Decree no. 2016-846 of 28 June 2016 on the modification, final shutdown and dismantling of basic nuclear installations, and subcontracting thereof.

[5] Order of 10 January 2003 authorising Andra to continue discharging gaseous and liquid effluents for the purpose of operating the Manche radioactive waste disposal facility.

"INVENTORY OF WASTE DISPOSED OF AT THE CSM AND RECORD OF CHANGES OVER TIME"

*This **"Thematic Sheet"** was prepared in 2019 by Andra, the operator of the Manche radioactive waste disposal facility (basic nuclear installation no. 66 - also known as "CSM"), with the aim of informing successive generations regarding the (radiological and chemical) inventory of radioactive waste packages present at the facility.*

The information presented below describes the full inventory of the CSM in 1994 (which was the year the final waste package received was placed in a disposal structure) (see § 1), as well as:

- *Changes to the inventory over time (see § 2);*
- *The distribution of the inventory across the various disposal structures (see § 3).*

This sheet is an integral part of the Summary Memory File (DSM) and complies with the regulatory requirement in Article 42 of Decree No.2007-1557, as amended by Decree No.2016-848 of 28 June 2016.

1 Total disposal inventory at the CSM in 1994

A total volume of 527,225 m^3 of radioactive waste has been disposed of at the CSM, packed in waste packages (i.e. metal drums and boxes or concrete hulls) that are in turn arranged in disposal structures (i.e. disposal cells or compartments). These disposal structures are distributed across a 12-hectare site in the municipality of La Hague (specifically, the delegated municipality of Digulleville).

The waste packages contain:

- Radionuclides (atoms with radioactive properties[1] that cause the inventory to change over time) and,
- Toxic chemical elements (the inventory of which does not change over time).

A diagram and photo of the disposal facility are included below, for illustrative purposes:

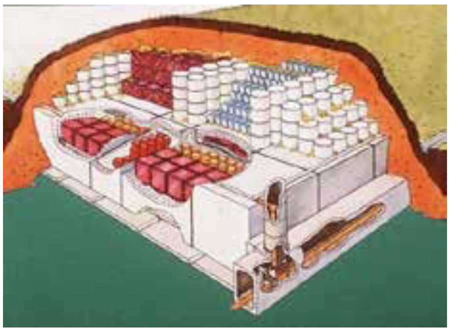


Figure 1 - Diagram of the CSM and photo taken during the operating phase. Waste packages are visible in the form of metal drums, metal containers and concrete hulls. The packages are assembled to form disposal structures

[1] **Radioactivity** is the physical phenomenon whereby unstable atomic nuclei (so-called radionuclides or radioisotopes) spontaneously transform into other atoms (in a process known as decay) by emitting particles of matter (i.e. electrons (beta radioactivity), helium nuclei (alpha radioactivity), neutrons, etc.) and energy (photons (gamma radioactivity) and kinetic energy) until a stable atom is obtained (decay chain).
Radionuclides are described using the following terminology, illustrated with the example of 3H (i.e. tritium): "H" is the notation of the chemical element "hydrogen" in Mendeleev's periodic table of the elements, and "3" is the atomic mass (i.e. the sum of the protons and neutrons in the nucleus of this radioactive hydrogen atom)

1.1 Total radiological inventory at the facility in 1994

The total radiological inventory refers to the total activity present at the disposal facility, stated in Gigabecquerels (GBq – i.e. 10^9 Bq or 1E+09 Bq - with 1 Becquerel representing one disintegration per second). Values are given for each of the 42 radionuclides[2] identified as present in the CSM inventory.

This information is compiled in Table 1 below. In addition, the radioactive period (in years)[3] and the main form(s) of radiation emitted are stated for each radionuclide.

> Important note:
> This radiological inventory data was established for June 1994 (which is when the final waste package was received). In the format currently used for this thematic sheet *(which may change during the BNI's closure phase)*, the choice was made to disregard the decrease in radionuclides between the date of disposal3 of the waste packages in the various structures and June 1994. The activity stated for each radionuclide therefore corresponds to the total activity received during the operation of the facility, disregarding its subsequent decay. This information is consistent with that presented in the Safety Report for the BNI and in the 2019 safety review file.
> It is important to note that this approach overestimates the inventories of certain short-lived radionuclides such as ^{3}H or "tritium" (which has a period of 12.3 years), ^{60}Co or "cobalt 60" (5.27 years), ^{90}Sr or "strontium 90" (28.8 years).

Radionuclides	Radioactive period (years) *From Jeff 3.1.1 - Database applicable in 2019*	Total activity at site (GBq) as of 30/06/1994
^{3}H	1.23E+01	1.27E+06
^{10}Be	1.60E+06	1.39E+00
^{14}C	5.70E+03	2.77E+05
^{36}Cl	3.01E+05	2.60E+03
^{41}Ca	1.03E+05	3.46E+01
^{59}Ni	7.60E+04	4.35E+04
^{60}Co	5.27E+00	1.49E+07
^{63}Ni	1.01E+02	5.42E+06
^{79}Se	3.77E+05	2.77E+01
^{90}Sr	2.88E+01	2.59E+06
^{93}Mo	4.00E+03	6.91E+00
^{93}Zr	1.53E+06	3.50E+02
^{94}Nb	2.00E+04	2.40E+03
^{99}Tc	2.14E+05	1.75E+03
^{107}Pd	6.50E+06	1.57E+01
^{108m}Ag	4.18E+02	6.93E+03

[2] The radioactive period of a radionuclide is the time required for the initial activity of a given radionuclide to decrease by half.
[3] The structures were filled over the course of the disposal facility's 25-year operating phase (between 1969 and 1994)

Radionuclides	Radioactive period (years) *From Jeff 3.1.1 - Database applicable in 2019*	Total activity at site (GBq) as of 30/06/1994
^{121m}Sn	5.50E+01	1.39E+02
^{126}Sn	2.30E+05	6.24E+01
^{129}I	1.61E+07	4.27E+00
^{135}Cs	2.30E+06	3.68E+02
^{137}Cs	3.00E+01	1.13E+07
^{151}Sm	9.00E+01	6.35E+04
^{226}Ra	1.60E+03	9.08E+03
^{228}Ra	5.75E+00	3.23E+04
^{232}Th	1.41E+10	1.11E+03
^{232}U	6.98E+01	9.94E+01
^{233}U	1.59E+05	5.35E+00
^{234}U	2.46E+05	3.31E+03
^{235}U	7.04E+08	2.61E+02
^{236}U	2.37E+07	1.04E+01
^{238}U	4.47E+09	3.25E+03
^{237}Np	2.14E+06	1.20E+02
^{238}Pu	8.77E+01	9.11E+04
^{239}Pu	2.41E+04	2.17E+05
^{240}Pu	6.56E+03	4.42E+04
^{241}Pu	1.43E+01	1.06E+07
^{242}Pu	3.74E+05	1.24E+02
^{241}Am	4.33E+02	3.80E+04
^{243}Am	7.36E+03	2.66E+02
^{242}Cm	4.46E-01	8.48E+02
^{243}Cm	3.00E+01	2.55E+01
^{244}Cm	1.80E+01	2.15E+04

Table 1 - Total inventory of each radionuclide contained in radioactive waste disposed of at the Manche disposal facility – As determined for June 1994

1.2 Inventory of chemical toxics

Radioactive waste packages disposed of at the disposal facility may also contain chemical toxics. The inventory of chemical toxics at the CSM[4] is defined in terms of masses (in kg) of the following chemical elements[5] that have been identified as having toxic properties: **boron** "B", **beryllium** "Be", **cadmium** "Cd", **chromium** "Cr" (total Cr and Cr VI), **mercury** "Hg", **nickel** "Ni", **lead** (in the form of lead metal "Pb" or lead sulphate "$PbSO_4$") and **uranium** "U".

This information is compiled in Table 2 below.

Total inventory of chemical toxics disposed of at CSM	
Chemical toxic	**Mass (kg)**
B	2.220E+05
Be	8.000E+00
Cd	1.530E+04
Cr	2.025E+03
Hg	8.790E+02
Ni	2.167E+04
Pb (metal)	1.742E+07
Pb ($PbSO_4$)	2.297E+06
U	2.643E+05

Table 2 - Inventory of toxic chemical elements contained in radioactive waste disposed of at the Manche disposal facility.

Notes:
The inventory presented in Table 2 corresponds to elements identified as disposed of at the CSM in 1994. Unlike radionuclides, the inventory of chemical toxics does not change over time.
This inventory relates only to waste packages and does not include any toxic elements potentially present in materials typically used to build disposal structures (e.g. concrete, gravel, etc.).

2 Changes to the radiological inventory over time

The radiological inventory (i.e. the activity associated with each radionuclide) changes over time as a consequence of radioactive decay (and the related radioactive decay law). This change is specific to each radionuclide, according to its radioactive period (see footnote 2).

To enable readers to visualise the evolution of the radiological inventory at the CSM, the choice was made to calculate the radiological inventories at various dates and present them in tables and curves (for selected radionuclides of interest).

[4] Toxicity measures the capacity of a chemical substance to cause death or negative health effects. Elements present in waste packages that are identified as toxic have been inventoried under the category “chemical toxics”.
[5] Notation: By convention at the time of publication, chemical elements are symbolised by a combination of 1 or 2 letters (1 uppercase letter followed where applicable by a lowercase letter) as stated in Mendeleev’s periodic table of the elements. For example, “B” represents boron, Ni corresponds to iron and Hg stands for mercury.

The radiological inventory was therefore calculated for the following dates:

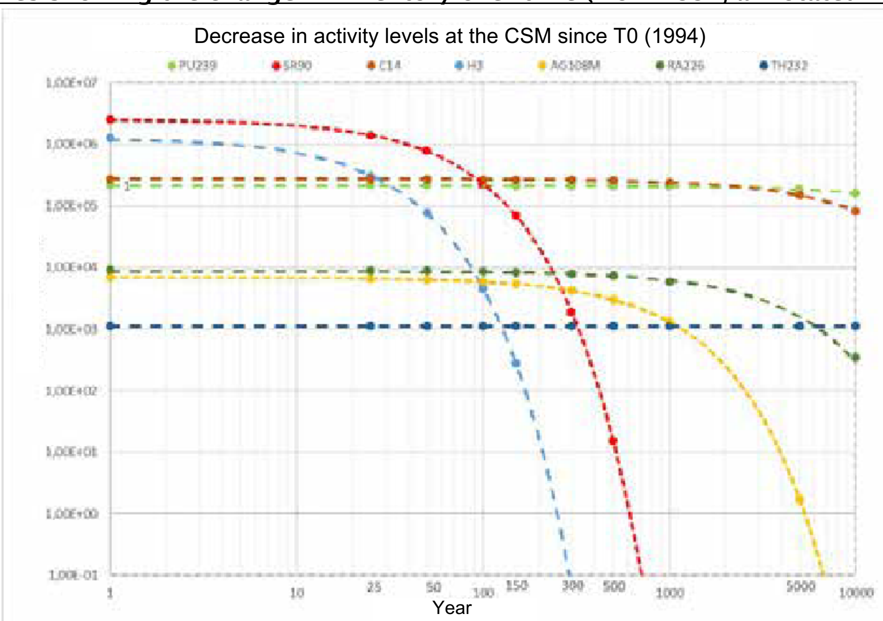
1994 (referred to as “T0”)
2019: T0 + 25 years
T0 + 50 years
T0 + 100 years
T0 + 150 years
T0 + 300 years
T0 + 500 years
T0 + 1,000 years
T0 + 10,000 years

The numerical results are presented in Table 3 below.

A few curves are included for a more visual representation. They are shown for a few radionuclides identified as being of particular interest:

- ✓ ^{3}H, as this radionuclide is present in the aquifer at the time of writing. Its presence is associated in particular with an operating incident that occurred in 1976 while filling disposal structure TB2 (see Figure 2 for a map showing the disposal structure locations);
- ✓ ^{90}Sr, ^{108m}Ag, and ^{14}C, as these radionuclides have been identified as major contributors to the impact of the disposal facility during the first 300 years, in the event that water infiltrates into the facility and subsequently transports these radionuclides through it and into the groundwater and nearby streams (i.e. the Sainte-Hélène and/or Grand Bel and/or Roteures streams). During this period, comprising the "closure phase" and subsequent “monitoring phase", the facility operator is expected to be present and monitor the disposal facility, the effectiveness of the cap and any environmental impacts;
- ✓ ^{239}Pu, ^{226}Ra and ^{232}Th, identified as potentially contributing to the facility’s impact in the long term (beyond 300 years), when the operator is no longer expected to be present to monitor the site and the cap is no longer required to limit water infiltration into the disposal facility. The impact of these radionuclides might derive either from them being transported by infiltration water through the disposal facility and then into groundwater and streams (as described above), or else from direct or atmospheric exposure (by ingestion or inhalation of contaminated dust) if waste packages were to become uncovered or in the event of intrusion into the disposal facility.

<u>Curves showing the change in inventory over time (from 1994, annotated “T0”)</u>:



	Activity in GBq									
	Total inventory at T0 (1994)	Total inventories (in GBq) after various time intervals (years after T0)								
Radionuclide	T0 (1994)	T0 + 25	T0 + 50	T0 + 100	T0 + 150	T0 + 300	T0 + 500	T0 + 1,000	T0 + 5,000	T0 + 10,000
^{3}H	1.27E+06	3.13E+05	7.66E+04	4.61E+03	2.77E+02	6.04E-02	7.91E-07	4.91E-19		
^{10}Be	1.39E+00	1.39E+00	1.39E+00	1.39E+00	1.39E+00	1.39E+00	1.39E+00	1.39E+00	1.38E+00	1.38E+00
^{14}C	2.77E+05	2.76E+05	2.75E+05	2.74E+05	2.72E+05	2.67E+05	2.61E+05	2.45E+05	1.51E+05	8.22E+04
^{36}Cl	2.60E+03	2.60E+03	2.60E+03	2.60E+03	2.60E+03	2.60E+03	2.60E+03	2.60E+03	2.57E+03	2.54E+03
^{41}Ca	3.46E+01	3.46E+01	3.46E+01	3.46E+01	3.46E+01	3.46E+01	3.45E+01	3.44E+01	3.35E+01	3.24E+01
^{59}Ni	4.35E+04	4.34E+04	4.34E+04	4.34E+04	4.34E+04	4.33E+04	4.33E+04	4.31E+04	4.15E+04	3.97E+04
^{60}Co	1.49E+07	5.57E+05	2.08E+04	2.90E+01	4.05E-02	1.10E-10	4.15E-22			
^{63}Ni	5.42E+06	4.57E+06	3.84E+06	2.72E+06	1.93E+06	6.87E+05	1.73E+05	5.52E+03	5.92E-09	6.47E-24
^{79}Se	2.77E+01	2.77E+01	2.77E+01	2.77E+01	2.77E+01	2.77E+01	2.77E+01	2.77E+01	2.75E+01	2.72E+01
^{90}Sr	2.59E+06	1.42E+06	7.77E+05	2.33E+05	6.99E+04	1.89E+03	1.53E+01	9.06E-05		
^{93m}Nb	0.00E+00	2.29E+02	3.07E+02	3.42E+02	3.47E+02	3.47E+02	3.47E+02	3.46E+02	3.43E+02	3.41E+02
^{93}Mo	6.91E+00	6.88E+00	6.85E+00	6.79E+00	6.73E+00	6.56E+00	6.34E+00	5.81E+00	2.91E+00	1.22E+00
^{93}Zr	3.50E+02	3.50E+02	3.50E+02	3.50E+02	3.50E+02	3.50E+02	3.50E+02	3.50E+02	3.49E+02	3.48E+02
^{94}Nb	2.40E+03	2.40E+03	2.39E+03	2.39E+03	2.38E+03	2.37E+03	2.36E+03	2.32E+03	2.02E+03	1.69E+03
^{99}Tc	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.72E+03	1.70E+03
^{107}Pd	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01	1.57E+01
^{108}mAg	6.93E+03	6.65E+03	6.38E+03	5.87E+03	5.40E+03	4.21E+03	3.02E+03	1.32E+03	1.74E+00	4.36E-04
^{121}mSn	1.39E+02	1.01E+02	7.38E+01	3.93E+01	2.09E+01	3.16E+00	2.54E-01	4.66E-04	5.97E-26	
^{126}Sn	6.24E+01	6.23E+01	6.23E+01	6.23E+01	6.23E+01	6.23E+01	6.23E+01	6.22E+01	6.14E+01	6.05E+01
^{129}I	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00	4.27E+00
^{135}Cs	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.68E+02	3.67E+02	3.67E+02
^{137}Cs	1.13E+07	6.33E+06	3.55E+06	1.12E+06	3.54E+05	1.11E+04	1.10E+02	1.07E-03		
^{151}Sm	6.35E+04	5.24E+04	4.32E+04	2.94E+04	2.00E+04	6.30E+03	1.35E+03	2.87E+01	1.20E-12	2.27E-29
^{210}Pb	0.00E+00	4.89E+03	7.08E+03	8.41E+03	8.54E+03	8.08E+03	7.42E+03	5.98E+03	1.14E+03	3.48E+02
^{226}Ra	9.08E+03	8.98E+03	8.89E+03	8.69E+03	8.51E+03	7.97E+03	7.31E+03	5.89E+03	1.13E+03	3.47E+02
^{227}Ac	0.00E+00	4.28E-02	1.38E-01	3.86E-01	6.55E-01	1.48E+00	2.58E+00	5.30E+00	2.61E+01	4.98E+01
^{228}Ra	3.23E+04	2.65E+03	1.19E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03
^{228}Th	0.00E+00	3.48E+03	1.29E+03	1.15E+03	1.14E+03	1.12E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03
^{229}Th	0.00E+00	1.26E-02	2.52E-02	5.05E-02	7.58E-02	1.52E-01	2.53E-01	5.10E-01	2.79E+00	6.06E+00
^{230}Th	0.00E+00	7.61E-01	1.52E+00	3.05E+00	4.58E+00	9.16E+00	1.53E+01	3.05E+01	1.50E+02	2.93E+02
^{231}Pa	0.00E+00	1.38E-01	2.76E-01	5.52E-01	8.27E-01	1.65E+00	2.75E+00	5.47E+00	2.63E+01	5.00E+01
^{232}Th	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03
^{232}U	9.94E+01	7.75E+01	6.05E+01	3.68E+01	2.24E+01	5.05E+00	6.93E-01	4.84E-03	2.72E-20	
^{233}U	5.35E+00	5.36E+00	5.37E+00	5.40E+00	5.43E+00	5.52E+00	5.65E+00	6.01E+00	9.29E+00	1.34E+01
^{234}U	3.31E+03	3.31E+03	3.32E+03	3.32E+03	3.33E+03	3.34E+03	3.34E+03	3.34E+03	3.34E+03	3.34E+03
^{235}U	2.61E+02	2.61E+02	2.61E+02	2.61E+02	2.61E+02	2.61E+02	2.61E+02	2.61E+02	2.62E+02	2.63E+02
^{236}U	1.04E+01	1.04E+01	1.04E+01	1.05E+01	1.06E+01	1.08E+01	1.10E+01	1.16E+01	1.54E+01	1.84E+01
^{237}Np	1.20E+02	1.21E+02	1.24E+02	1.30E+02	1.35E+02	1.49E+02	1.62E+02	1.82E+02	1.98E+02	1.98E+02
^{238}Pu	9.11E+04	7.48E+04	6.14E+04	4.13E+04	2.78E+04	8.51E+03	1.75E+03	3.36E+01	6.27E-13	4.31E-30
^{238}U	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03
^{239}Pu	2.17E+05	2.17E+05	2.17E+05	2.17E+05	2.16E+05	2.16E+05	2.14E+05	2.11E+05	1.88E+05	1.63E+05
^{240}Pu	4.42E+04	4.41E+04	4.40E+04	4.38E+04	4.36E+04	4.29E+04	4.20E+04	3.98E+04	2.61E+04	1.54E+04
^{241}Am	3.80E+04	2.77E+05	3.38E+05	3.39E+05	3.15E+05	2.48E+05	1.80E+05	8.08E+04	1.34E+02	4.45E-02
^{241}Pu	1.06E+07	3.16E+06	9.44E+05	8.41E+04	7.49E+03	5.29E+00	3.33E-04	1.04E-14		
^{242}Cm	8.48E+02	1.14E-14	1.54E-31							
^{242}Pu	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.23E+02	1.22E+02
^{243}Am	2.66E+02	2.66E+02	2.65E+02	2.64E+02	2.63E+02	2.59E+02	2.54E+02	2.42E+02	1.66E+02	1.04E+02
^{243}Cm	2.55E+01	1.43E+01	8.04E+00	2.53E+00	7.98E-01	2.49E-02	2.45E-04	2.36E-09		
^{244}Cm	2.15E+04	8.20E+03	3.13E+03	4.56E+02	6.66E+01	2.06E-01	9.33E-05	4.06E-13		

Table 3 - Presentation of the change in radiological inventory after various time intervals from the 1994 baseline (when the last package was disposed of at the CSM): years 1994, 2019, 2044, 2094, 2144, 2294, 2494, 2994, 6994 and 11994. Shaded rows indicate radionuclides with activities that increase over time. (These radionuclides are daughter products formed as their parent radionuclides decay – their initial inventory in the waste was zero).

3 Distribution of the inventory across the various disposal structures

The disposal facility consists of various structures built on two levels. In all, there are 104 disposal structures (see Figure 2).

The total radionuclide inventory (assessed for a June 1994 baseline) and toxic chemical elements (see § 1) is distributed among the 104 structures as indicated in the tables in the appendix below. This information served as an input to the impact assessments described in the "Thematic Sheet for the Summary Memory File" entitled *"Identifying whether there are risks associated with the presence of the disposal facility - Information yielded by the safety approach"*.

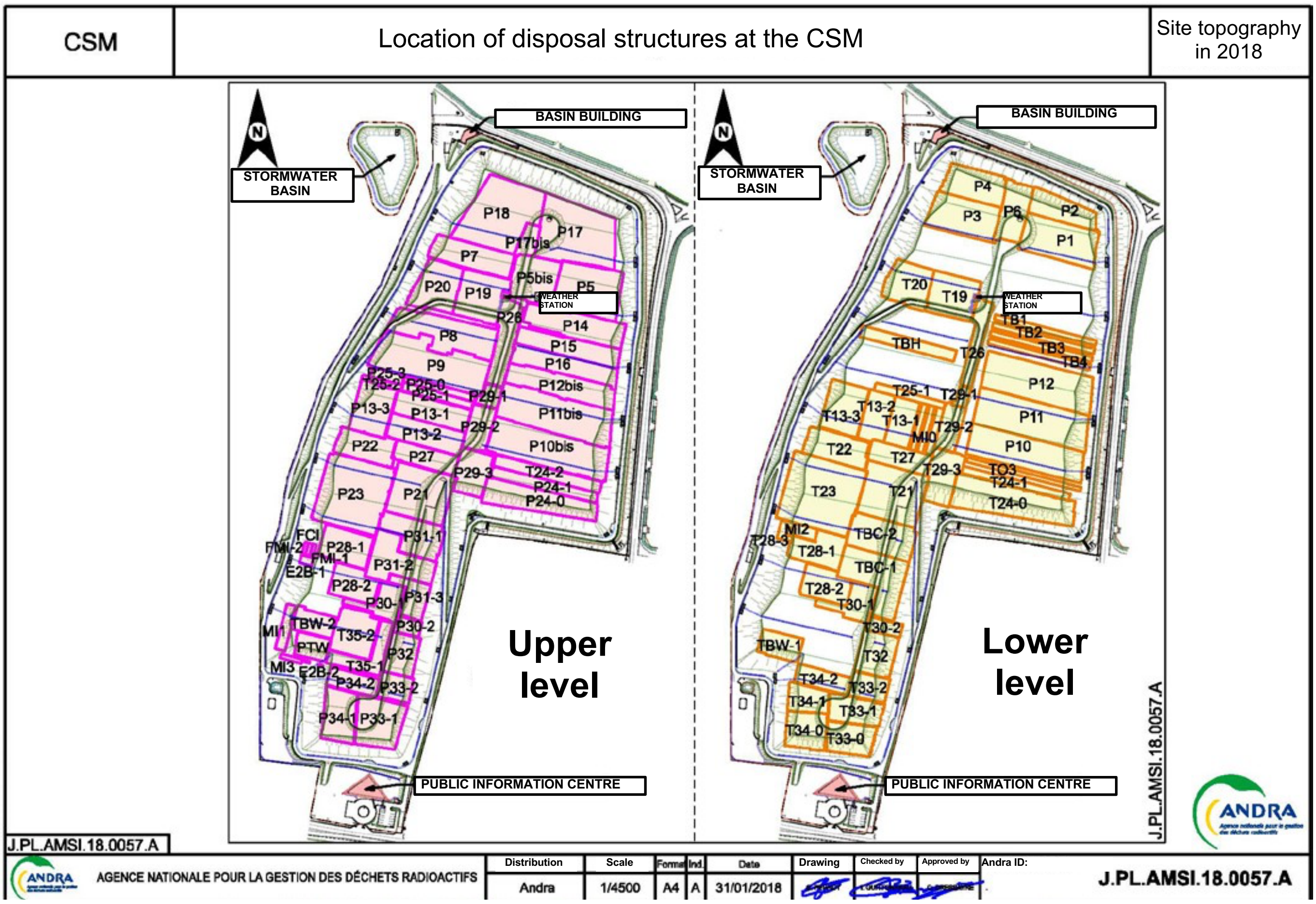


Figure 2 - Locations of the disposal structures at the Manche disposal facility.

4 Bibliography and link with the Detailed Memory File for more information

Readers seeking more information may consult the Detailed Memory File (DDM) for the CSM. Copies of the DDM are currently kept in two separate locations: at the CSM and in the National Archives of France.

The DDM is a corpus of documents, classified in a filing system structured chronologically and then thematically.

Information relating to the inventory can be found within this structure as follows:

- *"DDM search 1":*
  - ✓ *Initial, chronological level: Operating phase of the disposal facility (1969-1994)*
  - ✓ *Second, thematic level: Facility operation → Inventory*

A relevant document to look for is the RP2 catalogue in → Inventory → Radiological Inventory → RP2 Cocas Inventory → Document IFNTAGDI97018_A

- *"DDM search 2"*
  - ✓ *Initial, chronological level: Monitoring phase (1969-1994)*
  - ✓ *Second, thematic level: classification pending*

- Readers may refer to the regulatory ten-year "Safety Report" files for less granular information.

NB: At the time of publication, the (radiological and toxic) inventory data relating to each waste package at the disposal facility is recorded in a computer database named "COCAS – RP2", which is operated by Andra. Andra intends to continue curating this database for as long as waste disposal facilities remain in operation.

5 APPENDIX: INVENTORIES PRESENT IN EACH DISPOSAL STRUCTURE

5.1 Distribution of the radiological inventory by disposal structure

The radiological inventories present in the 104 disposal structures at the CSM are shown on pages 9 to 61 below.

Structure E2B-1	
Nuclide	**Activity (GBq)**
CS135	2.23E+01
CS137	6.38E+05
I129	2.23E-01
PD107	8.93E-01
SM151	3.83E+03
SR90	1.64E+05
TC99	1.02E+02

Structure E2B-2	
Nuclide	**Activity (GBq)**
CS135	3.17E+00
CS137	9.05E+04
I129	3.17E-02
PD107	1.27E-01
SM151	5.43E+02
SR90	3.35E+04
TC99	1.45E+01

Structure FCI	
Nuclide	**Activity (GBq)**
AG108M	2.00E+02
AM241	2.91E+00
AM243	1.80E-02
BE10	4.01E-02
C14	1.00E+04
CA41	1.00E+00
CL36	2.00E-01
CM242	3.99E-01
CM244	3.01E+00
CO60	2.00E+05
CS135	1.28E-01
CS137	3.66E+03
I129	1.28E-03
MO93	2.00E-01
NB94	1.00E+02
NI59	2.00E+03
NI63	1.20E+05
PD107	5.13E-03
PU238	1.42E+00
PU239	8.27E-01
PU240	1.28E+00
PU241	1.65E+02
SE79	8.02E-01
SM151	2.20E+01
SN121M	4.01E+00
SN126	1.80E+00
SR90	1.90E+03
TC99	5.86E-01
ZR93	2.57E+00

Structure FMI-1	
Nuclide	**Activity (GBq)**
AG108M	5.40E-01
AM241	9.10E+01
AM243	6.65E-02
BE10	1.08E-04
C14	1.69E+02
CA41	2.70E-03
CL36	5.40E-04
CM242	5.96E-02
CM244	8.22E+00
CO60	2.55E+03
CS135	5.91E-02
CS137	7.80E+03
H3	1.65E+01
I129	7.32E-04
MO93	5.40E-04
NB94	2.25E-01
NI59	4.24E+00
NI63	2.79E+02
NP237	8.53E-04
PD107	3.80E-03
PU238	1.24E+00
PU239	1.74E+01
PU240	3.21E-02
PU241	7.54E+00
SE79	2.16E-03
SM151	1.06E+01
SN121M	1.08E-02
SN126	4.86E-03
SR90	5.87E+01

Structure FMI-2	
Nuclide	Activity (GBq)
AG108M	1.02E+00
AM241	1.21E+01
AM243	7.62E-01
BE10	2.03E-04
C14	2.26E+02
CA41	5.08E-03
CL36	2.93E-02
CM242	1.86E-02
CM244	1.12E+00
CO60	1.75E+03
CS135	8.25E-02
CS137	8.63E+03
H3	6.86E+02
I129	3.59E-03
MO93	1.02E-03
NB94	4.15E-01
NI59	7.99E+00
NI63	8.01E+02
NP237	5.70E-04
PD107	3.24E-03
PU238	1.80E+01
PU239	3.25E+00
PU240	9.52E-02
PU241	3.90E+01
PU242	2.02E+00
RA226	5.00E+01
RA228	5.07E+00
SE79	4.07E-03
SM151	1.47E+01
SN121M	2.030E-02
SN126	9.150E-03
SR90	6.780E+01
TC99	5.380E-01
TH232	9.526E-01
U232	1.998E+00
U233	4.070E+00
U234	6.070E-02
U235	4.061E+01
U238	4.220E-02
ZR93	7.890E-02

Structure MI0	
Nuclide	Activity (GBq)
AG108M	4.07E+00
AM241	3.39E+01
AM243	5.95E-05
BE10	8.15E-04
C14	1.24E+03
CA41	2.04E-02
CL36	3.91E-03
CM244	8.99E-05
CO60	1.23E+04
CS135	1.13E-01
CS137	5.73E+04
H3	6.49E+03
I129	2.41E-03
MO93	4.07E-03
NB94	1.26E+00
NI59	2.10E+01
NI63	1.89E+03
NP237	2.52E-02
PD107	1.75E-02
PU238	3.73E+01
PU239	2.10E+03
PU240	9.77E+01
PU241	6.66E+03
PU242	9.58E-03
SE79	1.63E-02
SM151	2.39E+01
SN121M	8.15E-02
SN126	3.67E-02
SR90	7.49E+02
TC99	1.05E+00
ZR93	1.94E-01

Structure MI1	
Nuclide	Activity (GBq)
AG108M	4.57E+00
AM241	4.30E+02
AM243	1.38E+01
BE10	9.14E-04
C14	3.61E+03
CA41	2.29E-02
CL36	8.94E-03
CM242	2.49E-01
CM243	3.27E-02
CM244	1.09E+02
CO60	2.86E+04
CS135	7.59E-02
CS137	9.13E+04
H3	1.83E+04
I129	8.49E-04
MO93	4.57E-03
NB94	1.01E+00
NI59	1.36E+01
NI63	2.31E+03
NP237	3.27E-05
PD107	3.13E-03
PU238	2.02E+02
PU239	1.15E+02
PU240	7.11E+00
PU241	1.74E+03
PU242	9.21E-06
SE79	1.83E-02
SM151	1.31E+01
SN121M	9.14E-02
SN126	4.115E-02
SR90	1.262E+03
TC99	3.557E-01
U234	2.926E-01
U235	1.196E-02
U236	1.332E-04
U238	3.210E-01
ZR93	2.029E-01

Structure MI2	
Nuclide	Activity (GBq)
AG108M	1.12E+00
AM241	5.08E+00
BE10	2.24E-04
C14	2.05E+02
CA41	5.60E-03
CL36	2.97E-02
CM242	3.97E-01
CM244	2.30E+00
CO60	1.54E+03
CS135	6.09E-02
CS137	6.48E+03
H3	1.76E+03
I129	3.39E-03
MO93	1.12E-03
NB94	5.18E-01
NI59	1.02E+01
NI63	7.95E+02
NP237	5.72E-04
PD107	2.38E-03
PU238	1.19E+01
PU239	1.85E+00
PU240	2.90E-01
PU241	7.21E+01
SE79	4.48E-03
SM151	1.10E+01
SN121M	2.24E-02
SN126	1.01E-02
SR90	7.82E+01
TC99	4.40E-01
ZR93	6.61E-02

Structure MI3	
Nuclide	**Activity (GBq)**
AG108M	5.75E+00
AM241	3.53E+01
AM243	6.60E-02
BE10	1.15E-03
C14	2.87E+02
CA41	2.88E-02
CL36	1.04E-02
CM242	2.39E+00
CM244	5.46E+00
CO60	5.75E+03
CS135	1.03E-01
CS137	3.36E+03
H3	1.16E+02
I129	1.48E-03
MO93	5.75E-03
NB94	2.87E+00
NI59	5.73E+01
NI63	3.47E+03
NP237	9.16E-05
PD107	4.11E-03
PU238	9.01E+01
PU239	8.16E+00
PU240	1.05E+01
PU241	3.08E+02
PU242	-4.34E-03
SE79	2.30E-02
SM151	1.77E+01
SN121M	1.15E-01
SN126	5.18E-02
SR90	6.800E+02
TC99	4.970E-01

Structure P1	
Nuclide	**Activity (GBq)**
AG108M	2.55E+01
AM241	3.55E-01
BE10	5.09E-03
C14	1.16E+03
CA41	1.27E-01
CL36	2.55E-02
CO60	2.58E+04
CS135	8.27E-01
CS137	2.43E+04
H3	3.43E+02
I129	8.33E-03
MO93	2.55E-02
NB94	1.15E+01
NI59	2.23E+02
NI63	1.41E+04
NP237	8.71E-04
PD107	3.37E-02
PU238	8.53E+03
PU239	1.15E+04
PU240	5.38E+02
PU241	7.60E+05
RA226	2.07E+02
SE79	1.02E-01
SM151	1.42E+02
SN121M	5.09E-01
SN126	2.29E-01
SR90	1.54E+04
TC99	3.81E+00
TH232	1.65E+02
U234	1.31E+01
U235	5.91E-01

Structure P10	
Nuclide	**Activity (GBq)**
AG108M	5.84E+02
AM241	1.10E+01
BE10	1.17E-01
C14	2.92E+04
CA41	2.92E+00
CL36	5.84E-01
CO60	5.84E+05
CS135	3.69E+01
CS137	1.05E+06
H3	1.59E+04
I129	3.69E-01
MO93	5.84E-01
NB94	2.92E+02
NI59	5.84E+03
NI63	3.51E+05
PD107	1.47E+00
PU238	5.30E-02
PU239	7.61E+02
PU240	9.41E-02
SE79	2.34E+00
SM151	6.32E+03
SN121M	1.17E+01
SN126	5.26E+00
SR90	9.89E+03
TC99	1.68E+02
ZR93	5.03E+01

Structure P10bis	
Nuclide	**Activity (GBq)**
AG108M	7.49E+02
AM241	3.34E+02
AM243	1.86E-03
BE10	1.50E-01
C14	3.73E+04
CA41	3.75E+00
CL36	7.85E-01
CM242	4.49E-01
CM243	1.93E-04
CM244	1.11E+00
CO60	7.49E+05
CS135	3.36E+01
CS137	9.63E+05
H3	2.43E+04
I129	3.40E-01
MO93	7.49E-01
NB94	3.72E+02
NI59	7.42E+03
NI63	4.50E+05
NP237	9.79E-03
PD107	1.35E+00
PU238	9.14E+02
PU239	7.92E+03
PU240	1.33E+03
PU241	1.62E+05
PU242	1.73E-01

Structure P11	
Nuclide	**Activity (GBq)**
AG108M	6.08E+02
AM241	2.27E-01
BE10	1.22E-01
C14	3.02E+04
CA41	3.04E+00
CL36	6.08E-01
CO60	6.08E+05
CS135	3.53E+01
CS137	1.01E+06
H3	1.45E+04
I129	3.53E-01
MO93	6.08E-01
NB94	3.02E+02
NI59	6.03E+03
NI63	3.63E+05
NP237	1.29E-03
PD107	1.41E+00
PU238	2.68E+00
PU239	4.09E+02
PU240	4.91E-01
PU241	1.26E+03
SE79	2.43E+00
SM151	6.05E+03
SN121M	1.22E+01
SN126	5.47E+00
SR90	1.14E+04
TC99	1.61E+02
ZR93	5.04E+01

Structure P11bis	
Nuclide	**Activity (GBq)**
AG108M	2.94E+01
AM241	4.09E+02
AM243	9.34E-03
BE10	6.07E-03
C14	1.33E+03
CA41	1.52E-01
CL36	5.92E-02
CM242	6.79E-04
CM243	9.35E-05
CM244	4.39E-02
CO60	2.93E+04
CS135	1.18E+00
CS137	3.57E+04
H3	4.54E+03
I129	1.52E-02
MO93	2.94E-02
NB94	1.30E+01
NI59	2.45E+02
NI63	1.86E+04
NP237	3.51E-03
PD107	5.37E-02
PU238	1.51E+03
PU239	1.42E+04
PU240	2.09E+03
PU241	2.32E+05
PU242	5.61E-01
RA226	3.74E+02
RA228	2.21E+03

Structure P12	
Nuclide	Activity (GBq)
AG108M	3.12E+02
AM241	1.55E-01
AM243	3.77E-03
BE10	6.23E-02
C14	1.55E+04
CA41	1.56E+00
CL36	3.13E-01
CM242	3.69E-01
CM244	2.07E+00
CO60	3.12E+05
CS135	1.17E+01
CS137	3.34E+05
H3	1.18E+04
I129	1.17E-01
MO93	3.12E-01
NB94	1.55E+02
NI59	3.09E+03
NI63	1.86E+05
NP237	9.07E-04
PD107	4.67E-01
PU238	1.88E+00
PU239	5.08E+02
PU240	3.44E-01
PU241	9.00E+01
RA226	4.03E+01
SE79	1.25E+00
SM151	2.00E+03
SN121M	6.23E+00
SN126	2.81E+00
SR90	1.130E+04
TC99	5.340E+01
TH232	1.073E-01
U234	7.385E-01
U235	7.074E-01
U238	7.385E-01
ZR93	2.220E+01

Structure P12bis	
Nuclide	Activity (GBq)
AG108M	1.46E+01
AM241	1.64E+02
AM243	3.69E-07
BE10	2.91E-03
C14	6.30E+02
CA41	7.28E-02
CL36	2.52E-02
CM242	5.24E+00
CM244	1.37E+01
CO60	1.46E+04
CS135	2.06E+00
CS137	6.02E+04
H3	9.49E+02
I129	2.21E-02
MO93	1.46E-02
NB94	5.91E+00
NI59	1.11E+02
NI63	8.38E+03
NP237	2.05E-03
PD107	8.70E-02
PU238	1.25E+03
PU239	4.54E+03
PU240	1.85E+03
PU241	1.60E+05
PU242	8.36E-01
RA226	1.42E+02
RA228	8.56E+02
SE79	5.83E-02
SM151	3.54E+02
SN121M	2.91E-01
SN126	1.31E-01
SR90	1.88E+04
TC99	9.66E+00
TH232	6.95E+00
U232	5.40E-04
U234	1.69E+02

Structure P13-1	
Nuclide	**Activity (GBq)**
AG108M	8.85E+01
AM241	3.89E+02
AM243	1.73E+00
BE10	1.77E-02
C14	1.63E+03
CA41	4.42E-01
CL36	6.33E+00
CM242	1.16E+01
CM244	1.61E+02
CO60	1.03E+05
CS135	9.70E-01
CS137	3.20E+04
H3	1.94E+03
I129	1.40E-02
MO93	8.84E-02
NB94	1.11E+01
NI59	1.01E+02
NI63	1.15E+05
NP237	2.97E+00
PD107	3.93E-02
PU238	3.96E+02
PU239	1.42E+03
PU240	4.24E+02
PU241	2.35E+04
PU242	1.81E-01
RA226	3.78E-01
SE79	3.54E-01
SM151	1.67E+02
SN121M	1.77E+00
SN126	7.962E-01
SR90	1.779E+04
TC99	4.707E+00
TH232	3.217E-02
U232	7.794E-02
U233	9.600E-02
U234	1.828E+01
U235	6.928E-01
U236	7.156E-01
U238	1.814E+01
ZR93	6.332E-01

Structure P13-2	
Nuclide	**Activity (GBq)**
AG108M	1.26E+02
AM241	9.43E+02
AM243	3.63E+00
BE10	2.51E-02
C14	2.43E+03
CA41	6.28E-01
CL36	3.19E+01
CM242	3.23E+01
CM244	3.40E+02
CO60	1.67E+05
CS135	2.81E+00
CS137	9.21E+04
H3	5.11E+03
I129	4.06E-02
MO93	1.25E-01
NB94	1.57E+01
NI59	1.35E+02
NI63	1.57E+05
NP237	1.04E+00
PD107	1.13E-01
PU238	8.80E+02
PU239	2.41E+03
PU240	8.54E+02
PU241	5.93E+04
PU242	2.53E+00
RA226	3.13E-01
SE79	5.02E-01
SM151	4.85E+02
SN121M	2.51E+00
SN126	1.13E+00
SR90	4.87E+04
TC99	1.36E+01
U232	3.76E-03
U233	1.90E-04
U234	4.02E+00
U235	1.38E+00
U236	6.90E-02
U238	1.02E+01
ZR93	1.25E+00

Structure P13-3	
Nuclide	Activity (GBq)
AG108M	3.31E+01
AM241	7.64E+01
AM243	9.47E-02
BE10	6.63E-03
C14	6.12E+02
CA41	1.66E-01
CL36	1.58E-01
CM242	1.17E+01
CM244	2.38E+01
CO60	7.06E+06
CS135	2.22E-01
CS137	2.04E+04
H3	9.23E+02
I129	1.71E-02
MO93	3.31E-02
NB94	4.39E+00
NI59	4.13E+01
NI63	3.86E+04
NP237	7.74E-01
PD107	1.16E-02
PU238	2.00E+02
PU239	1.27E+03
PU240	2.93E+02
PU241	1.90E+04
PU242	1.35E-01
RA226	1.75E+00
SE79	1.33E-01
SM151	4.18E+01
SN121M	6.63E-01
SN126	2.983E-01
SR90	1.896E+03
TC99	1.985E+00
TH232	2.966E-02
U233	1.100E-04
U234	2.337E+01
U235	1.368E+00
U236	1.279E-01
U238	1.793E+01
ZR93	3.778E-01

Structure P14	
Nuclide	Activity (GBq)
AG108M	1.46E+01
AM241	1.82E+01
BE10	2.92E-03
C14	4.16E+03
CA41	7.31E-02
CL36	4.82E+02
CM242	3.12E-02
CM244	8.13E-02
CO60	1.46E+04
CS135	6.38E-01
CS137	3.00E+04
H3	6.30E+04
I129	1.89E-02
MO93	1.15E-02
NB94	3.48E+00
NI59	4.58E+01
NI63	8.76E+03
NP237	1.14E-02
PD107	2.82E-02
PU238	3.12E+02
PU239	1.86E+03
PU240	4.87E+02
PU241	5.60E+04
PU242	2.28E-01
RA226	8.38E+01
RA228	4.76E+02
SE79	5.85E-02
SM151	1.13E+02
SN121M	2.92E-01
SN126	1.32E-01
SR90	6.67E+03
TC99	3.75E+00
TH232	4.09E+00
U234	1.31E+01
U235	7.31E-01
U238	1.31E+01
ZR93	5.06E-01

Structure P15	
Nuclide	**Activity (GBq)**
AG108M	1.43E+02
AM241	7.31E+01
AM243	5.33E-04
BE10	2.86E-02
C14	7.13E+03
CA41	7.16E-01
CL36	1.61E-01
CM242	2.86E+00
CM244	7.44E+00
CO60	1.43E+05
CS135	7.57E+00
CS137	2.18E+05
H3	1.87E+03
I129	7.74E-02
MO93	1.43E-01
NB94	7.08E+01
NI59	1.41E+03
NI63	8.53E+04
NP237	2.40E-03
PD107	3.03E-01
PU238	5.89E+02
PU239	4.40E+03
PU240	6.90E+02
PU241	8.38E+04
PU242	2.76E-01
RA226	8.33E+01
RA228	4.76E+02
SE79	5.72E-01
SM151	1.30E+03
SN121M	2.862E+00
SN126	1.288E+00
SR90	5.353E+03
TC99	3.472E+01
TH232	4.091E+00
U232	1.620E-03
U234	2.054E+01
U235	1.211E+00
U236	1.458E-02
U238	2.045E+01
ZR93	1.129E+01

Structure P16	
Nuclide	**Activity (GBq)**
AG108M	3.79E+01
AM241	2.30E+02
BE10	7.57E-03
C14	1.38E+03
CA41	1.89E-01
CL36	3.71E-01
CM242	5.77E+00
CM244	3.73E+01
CO60	3.79E+04
CS135	1.40E+00
CS137	4.82E+04
H3	6.70E+02
I129	2.27E-02
MO93	3.79E-02
NB94	1.36E+01
NI59	2.44E+02
NI63	1.89E+04
NP237	2.26E-02
PD107	6.29E-02
PU238	9.12E+02
PU239	3.60E+03
PU240	8.58E+02
PU241	1.07E+05
PU242	3.33E-01
RA226	6.67E+01
RA228	3.81E+02
SE79	1.51E-01
SM151	2.44E+02
SN121M	7.57E-01
SN126	3.41E-01
SR90	1.36E+04
TC99	7.15E+00
TH232	3.27E+00
U232	9.18E-03
U234	4.94E+01
U235	2.26E+00
U236	8.29E-02
U238	4.89E+01
ZR93	1.32E+00

Structure P17	
Nuclide	**Activity (GBq)**
AG108M	3.44E+01
AM241	2.58E+01
AM243	4.64E-03
BE10	6.87E-03
C14	1.08E+03
CA41	1.72E-01
CL36	5.73E-02
CM242	2.77E+00
CM244	6.92E+00
CO60	3.44E+04
CS135	4.07E-01
CS137	1.52E+04
H3	1.15E+03
I129	7.91E-03
MO93	3.44E-02
NB94	9.58E+00
NI59	1.60E+02
NI63	2.89E+04
NP237	1.02E-02
PD107	1.93E-02
PU238	3.55E+02
PU239	1.14E+03
PU240	2.71E+02
PU241	3.36E+04
PU242	1.20E-01
RA226	5.00E+01
RA228	2.85E+02
SE79	1.37E-01
SM151	7.15E+01
SN121M	6.870E-01
SN126	3.090E-01
SR90	4.240E+03
TC99	2.190E+00
TH232	1.320E+02
U234	6.580E+01
U235	1.080E+01
U236	2.110E-02
U238	6.630E+01
ZR93	1.090E+00

Structure P17bis	
Nuclide	**Activity (GBq)**
AG108M	4.56E+01
AM241	7.66E-01
AM243	1.33E-03
BE10	9.12E-03
C14	1.70E+03
CA41	2.28E-01
CL36	1.15E-01
CM244	2.00E-03
CO60	4.56E+04
CS135	1.62E+00
CS137	5.33E+04
H3	6.09E+02
I129	2.35E-02
MO93	4.56E-02
NB94	1.68E+01
NI59	3.05E+02
NI63	2.64E+04
NP237	6.63E-03
PD107	6.65E-02
PU238	1.34E+01
PU239	4.28E+01
PU240	6.51E+00
PU241	9.33E+02
PU242	1.55E-03
SE79	1.82E-01
SM151	2.80E+02
SN121M	9.12E-01
SN126	4.10E-01
SR90	1.91E+03
TC99	7.91E+00
U234	7.05E-01
U235	5.27E-02
U238	7.05E-01
ZR93	2.98E+00

Structure P18	
Nuclide	**Activity (GBq)**
AG108M	4.03E+01
AM241	1.64E+02
AM243	2.34E+00
BE10	8.06E-03
C14	1.32E+03
CA41	2.01E-01
CL36	1.33E-01
CM242	5.51E+00
CM244	1.79E+01
CO60	4.03E+04
CS135	1.09E+00
CS137	4.11E+04
H3	6.90E+02
I129	2.14E-02
MO93	4.03E-02
NB94	1.22E+01
NI59	2.10E+02
NI63	3.05E+04
NP237	1.32E-02
PD107	4.70E-02
PU238	5.04E+02
PU239	1.54E+03
PU240	1.56E+02
PU241	5.74E+04
PU242	2.24E-02
RA226	1.33E+02
RA228	4.19E+01
SE79	1.61E-01
SM151	1.90E+02
SN121M	8.060E-01
SN126	3.630E-01
SR90	1.360E+03
TC99	5.720E+00
TH232	8.860E+00
U234	1.200E+01
U235	2.660E+01
U238	1.200E+01
ZR93	2.000E+00

Structure P19	
Nuclide	**Activity (GBq)**
AG108M	3.50E+01
AM241	6.28E+02
AM243	2.61E-01
BE10	6.99E-03
C14	7.19E+02
CA41	1.75E-01
CL36	1.46E+01
CM242	3.45E+01
CM243	4.71E-03
CM244	8.01E+01
CO60	3.50E+04
CS135	5.78E-01
CS137	2.05E+04
H3	2.56E+03
I129	9.99E-03
MO93	3.49E-02
NB94	4.53E+00
NI59	3.98E+01
NI63	3.92E+04
NP237	3.80E-01
PD107	2.62E-02
PU238	6.14E+02
PU239	6.15E+02
PU240	5.31E+02
PU241	1.23E+04
PU242	3.87E-02
RA226	3.29E-07
SE79	1.40E-01
SM151	1.01E+02
SN121M	6.99E-01
SN126	3.15E-01
SR90	5.89E+03
TC99	3.00E+00
U232	1.85E-02
U234	3.49E+01
U235	8.07E-01
U236	1.55E-01
U238	3.34E+01

Structure P2	
Nuclide	**Activity (GBq)**
AG108M	9.08E+00
AM241	1.78E-02
BE10	1.82E-03
C14	4.64E+02
CA41	4.54E-02
CL36	9.08E-03
CO60	9.09E+03
CS135	3.46E-01
CS137	9.90E+03
H3	3.22E+02
I129	3.48E-03
MO93	9.08E-03
NB94	4.40E+00
NI59	8.73E+01
NI63	5.31E+03
NP237	3.84E-05
PD107	1.40E-02
PU238	5.35E+03
PU239	9.66E+03
PU240	5.76E+02
PU241	5.79E+05
RA226	1.62E+02
RA228	1.59E+01
SE79	3.63E-02
SM151	5.94E+01
SN121M	1.82E-01
SN126	8.17E-02
SR90	5.74E+03
TC99	1.59E+00
TH232	5.030E+01
U234	1.920E+01
U235	8.630E-01
U238	1.920E+01
ZR93	6.510E-01

Structure P20	
Nuclide	**Activity (GBq)**
AG108M	7.44E+01
AM241	6.34E+02
AM243	2.70E-01
BE10	1.49E-02
C14	1.19E+03
CA41	3.72E-01
CL36	2.47E-01
CM242	9.25E+01
CM243	2.07E-03
CM244	1.66E+02
CO60	7.44E+04
CS135	4.66E-01
CS137	3.42E+04
H3	2.50E+03
I129	2.69E-02
MO93	7.44E-02
NB94	9.50E+00
NI59	7.52E+01
NI63	7.40E+04
NP237	2.88E-02
PD107	2.62E-02
PU238	1.59E+03
PU239	1.12E+03
PU240	9.56E+02
PU241	6.21E+04
PU242	1.09E-01
SE79	2.97E-01
SM151	8.68E+01
SN121M	1.49E+00
SN126	6.69E-01
SR90	5.22E+03
TC99	3.70E+00
U232	2.18E-02
U234	1.39E+01

Structure P21	
Nuclide	Activity (GBq)
AG108M	4.03E+01
AM241	1.03E+03
AM243	9.54E-01
BE10	8.06E-03
C14	1.37E+03
CA41	2.02E-01
CL36	7.02E+01
CM242	7.57E+01
CM244	1.20E+02
CO60	4.04E+04
CS135	1.12E+00
CS137	4.34E+04
H3	9.87E+03
I129	2.31E-02
MO93	3.99E-02
NB94	6.70E+00
NI59	7.84E+01
NI63	3.98E+04
NP237	4.57E-01
PD107	4.91E-02
PU238	1.61E+03
PU239	7.78E+03
PU240	2.36E+03
PU241	2.18E+05
PU242	9.15E-01
RA226	1.30E-02
SE79	1.61E-01
SM151	1.95E+02
SN121M	8.06E-01
SN126	3.628E-01
SR90	1.682E+04
TC99	5.966E+00
TH232	1.015E-01
U232	2.773E-03
U233	9.300E-04
U234	9.283E+00
U235	6.760E-01
U236	1.315E-01
U238	1.086E+01
ZR93	7.654E-01

Structure P22	
Nuclide	Activity (GBq)
AG108M	1.98E+01
AM241	6.70E+02
AM243	3.45E+00
BE10	3.96E-03
C14	3.72E+02
CA41	9.91E-02
CL36	5.05E-02
CM242	8.38E+00
CM244	2.42E+02
CO60	1.98E+04
CS135	1.58E+00
CS137	4.92E+04
H3	9.26E+02
I129	2.01E-02
MO93	1.98E-02
NB94	3.31E+00
NI59	3.69E+01
NI63	1.62E+04
NP237	1.28E-01
PD107	6.81E-02
PU238	3.80E+02
PU239	4.29E+03
PU240	1.12E+03
PU241	6.90E+04
PU242	1.73E-01
RA226	6.30E-02
SE79	7.93E-02
SM151	2.73E+02
SN121M	3.96E-01
SN126	1.78E-01
SR90	2.81E+04
TC99	7.64E+00
U232	1.23E-02
U233	7.10E-05
U234	7.66E+00
U235	2.87E-01
U236	1.44E-01
U238	9.59E+00
ZR93	5.22E-01

Structure P23	
Nuclide	**Activity (GBq)**
AG108M	9.04E+01
AM241	4.34E+02
AM243	3.70E-01
BE10	1.81E-02
C14	2.19E+03
CA41	4.52E-01
CL36	5.50E+01
CM242	7.91E+01
CM244	2.39E+02
CO60	9.05E+04
CS135	6.86E-01
CS137	4.46E+04
H3	9.34E+03
I129	3.33E-02
MO93	9.00E-02
NB94	1.37E+01
NI59	1.52E+02
NI63	1.03E+05
NP237	6.53E+01
PD107	3.04E-02
PU238	1.21E+03
PU239	2.16E+03
PU240	8.04E+02
PU241	1.54E+05
PU242	6.57E+01
RA226	1.80E-02
SE79	3.62E-01
SM151	1.24E+02
SN121M	1.81E+00
SN126	8.136E-01
SR90	5.550E+03
TC99	4.790E+00
TH232	6.541E-01
U232	6.534E+01
U233	7.400E-05
U234	8.426E+01
U235	4.810E+00
U236	8.481E-01
U238	6.950E+01
ZR93	1.191E+00

Structure P24-0	
Nuclide	**Activity (GBq)**
AG108M	2.17E+01
AM241	2.54E+01
AM243	1.77E-01
BE10	4.34E-03
C14	3.91E+02
CA41	1.09E-01
CL36	1.26E+00
CM242	6.34E+00
CM244	6.02E+00
CO60	2.17E+04
CS135	9.51E-02
CS137	9.67E+03
H3	3.10E+03
I129	8.33E-03
MO93	2.17E-02
NB94	3.10E+00
NI59	2.99E+01
NI63	2.14E+04
NP237	2.22E+00
PD107	3.87E-03
PU238	1.25E+02
PU239	1.24E+02
PU240	7.43E+01
PU241	9.31E+03
PU242	8.75E-02
RA226	7.84E-07
SE79	8.68E-02
SM151	1.78E+01
SN121M	4.34E-01
SN126	1.95E-01
SR90	1.03E+03
TC99	8.71E-01
TH232	4.23E-01
U232	2.57E-03
U234	1.69E+01
U235	7.22E-01
U236	1.51E-01
U238	1.36E+01
ZR93	3.91E-01

Structure P24-1	
Nuclide	**Activity (GBq)**
AG108M	3.23E+01
AM241	1.14E+01
AM243	1.84E-02
BE10	6.47E-03
C14	6.69E+02
CA41	1.62E-01
CL36	7.72E-02
CM242	1.55E+01
CM244	4.36E+00
CO60	3.24E+04
CS135	1.31E-01
CS137	1.06E+04
H3	4.15E+02
I129	8.38E-03
MO93	3.23E-02
NB94	4.08E+00
NI59	3.70E+01
NI63	4.02E+04
NP237	3.09E-01
PD107	5.27E-03
PU238	8.33E+01
PU239	1.19E+02
PU240	6.62E+01
PU241	5.70E+03
PU242	5.60E-02
RA226	6.40E-08
SE79	1.29E-01
SM151	2.38E+01
SN121M	6.47E-01
SN126	2.911E-01
SR90	1.516E+03
TC99	1.014E+00
TH232	2.069E-01
U232	1.377E-03
U233	1.100E-03
U234	3.270E+00
U235	1.602E-01
U236	3.385E-02
U238	5.557E+00
ZR93	2.666E-01

Structure P25-0	
Nuclide	**Activity (GBq)**
AG108M	3.68E+01
AM241	2.94E+01
AM243	4.44E-02
BE10	7.37E-03
C14	6.48E+02
CA41	1.84E-01
CL36	1.71E-02
CM242	4.97E-04
CM243	5.07E-04
CM244	1.09E+00
CO60	3.69E+04
CS135	1.51E-02
CS137	1.78E+03
H3	1.76E+02
I129	1.58E-03
MO93	3.68E-02
NB94	4.45E+00
NI59	3.93E+01
NI63	4.87E+04
NP237	7.81E-04
PD107	7.37E-04
PU238	2.02E+01
PU239	1.46E+01
PU240	1.32E+01
PU241	1.90E+03
PU242	2.04E-02
RA226	7.84E-02
SE79	1.47E-01
SM151	2.92E+00
SN121M	7.37E-01
SN126	3.32E-01
SR90	2.55E+02
TC99	1.58E-01
TH232	1.08E+00
U232	8.11E-03
U234	2.01E+00
U235	7.24E-02
U236	5.91E-02
U238	1.32E+00
ZR93	1.41E-01

Structure P25-1	
Nuclide	**Activity (GBq)**
AG108M	1.23E+02
AM241	9.89E+01
AM243	2.12E+00
BE10	2.46E-02
C14	2.19E+03
CA41	6.16E-01
CL36	2.87E-01
CM242	2.97E-01
CM243	1.20E+00
CM244	1.44E+02
CO60	1.23E+05
CS135	6.75E-01
CS137	4.73E+04
H3	8.75E+02
I129	3.64E-02
MO93	1.23E-01
NB94	1.49E+01
NI59	1.31E+02
NI63	1.61E+05
NP237	3.35E-01
PD107	5.46E-02
PU238	3.12E+02
PU239	6.63E+01
PU240	1.13E+02
PU241	1.48E+04
PU242	1.01E-02
RA226	4.91E-01
SE79	4.93E-01
SM151	1.31E+02
SN121M	2.464E+00
SN126	1.109E+00
SR90	6.406E+03
TC99	5.807E+00
TH232	1.361E-02
U232	8.616E-04
U234	5.141E-01
U235	1.800E-02
U236	1.290E-02
U238	3.926E-01
ZR93	5.386E-01

Structure P25-3	
Nuclide	**Activity (GBq)**
AG108M	1.24E+00
AM241	1.07E+01
AM243	9.07E-02
BE10	2.49E-04
C14	3.90E+02
CA41	6.22E-03
CL36	4.72E+01
CM242	6.19E-03
CM243	2.67E-04
CM244	8.18E+00
CO60	1.24E+03
CS135	2.45E-02
CS137	8.32E+02
H3	6.57E+03
I129	3.85E-04
MO93	9.37E-04
NB94	2.01E-01
NI59	1.42E+00
NI63	6.57E+02
NP237	3.91E-03
PD107	1.10E-03
PU238	1.33E+01
PU239	8.55E+00
PU240	9.37E+00
PU241	8.86E+02
PU242	4.40E-04
SE79	4.97E-03
SM151	4.27E+00
SN121M	2.49E-02
SN126	1.12E-02
SR90	3.97E+02
TC99	1.24E-01
U232	9.42E-03
U234	6.55E-01
U235	1.58E-02
U236	7.11E-02
U238	4.61E-01
ZR93	3.26E-02

Structure P26	
Nuclide	Activity (GBq)
AG108M	6.80E+01
AM241	2.30E+02
AM243	1.67E+00
BE10	1.36E-02
C14	1.23E+03
CA41	3.40E-01
CL36	9.09E-02
CM242	8.20E+00
CM244	1.70E+02
CO60	6.80E+04
CS135	6.55E-01
CS137	2.59E+04
H3	1.28E+03
I129	1.42E-02
MO93	6.80E-02
NB94	9.13E+00
NI59	8.66E+01
NI63	7.72E+04
NP237	2.70E-01
PD107	2.98E-02
PU238	3.55E+02
PU239	2.34E+02
PU240	1.50E+02
PU241	2.13E+04
PU242	4.63E-02
RA226	1.40E+00
SE79	2.72E-01
SM151	1.15E+02
SN121M	1.36E+00
SN126	6.117E-01
SR90	1.249E+04
TC99	3.568E+00
TH232	3.082E-02
U232	5.633E-02
U233	1.900E-04
U234	1.665E+01
U235	5.904E-01
U236	5.082E-01
U238	1.707E+01
ZR93	7.845E-01

Structure P27	
Nuclide	Activity (GBq)
AG108M	8.49E+01
AM241	2.45E+02
AM243	1.89E+00
BE10	1.70E-02
C14	3.49E+03
CA41	4.24E-01
CL36	1.39E+01
CM242	5.56E+01
CM243	1.10E+00
CM244	2.35E+02
CO60	8.49E+04
CS135	1.41E+00
CS137	4.53E+04
H3	3.41E+03
I129	1.95E-02
MO93	8.48E-02
NB94	3.23E+01
NI59	6.08E+02
NI63	6.73E+04
NP237	5.90E-02
PD107	5.66E-02
PU238	5.24E+02
PU239	5.18E+02
PU240	3.12E+02
PU241	3.08E+04
PU242	4.45E-01
RA226	6.16E-01
SE79	3.40E-01
SM151	2.42E+02
SN121M	1.70E+00
SN126	7.64E-01
SR90	1.40E+04
TC99	6.76E+00
TH232	1.64E-02
U232	1.16E-03
U234	1.47E+01
U235	7.01E-01
U236	3.74E-01
U238	1.41E+01
ZR93	3.25E+00

Structure P28-1	
Nuclide	Activity (GBq)
AG108M	1.09E+02
AM241	3.86E+03
AM243	4.28E+01
BE10	2.18E-02
C14	1.74E+03
CA41	5.45E-01
CL36	3.26E+01
CM242	4.04E-02
CM243	1.01E-01
CM244	3.25E+03
CO60	1.09E+05
CS135	1.99E+01
CS137	5.76E+05
H3	9.15E+03
I129	2.07E-01
MO93	1.09E-01
NB94	1.44E+01
NI59	8.91E+01
NI63	6.26E+04
NP237	8.86E-01
PD107	8.12E-01
PU238	6.22E+02
PU239	8.66E+02
PU240	4.40E+02
PU241	5.43E+04
PU242	1.33E+00
SE79	4.36E-01
SM151	3.42E+03
SN121M	2.18E+00
SN126	9.810E-01
SR90	3.428E+05
TC99	9.200E+01
U232	1.774E-02
U233	1.132E-02
U234	1.583E+00
U235	6.000E-02
U236	2.025E-01
U238	1.108E+00
ZR93	3.936E+00

Structure P28-2	
Nuclide	Activity (GBq)
AG108M	1.50E+02
AM241	1.06E+03
AM243	8.54E+00
BE10	3.00E-02
C14	2.56E+03
CA41	7.50E-01
CL36	7.19E+01
CM242	2.21E-03
CM243	1.28E+00
CM244	5.99E+02
CO60	1.50E+05
CS135	4.36E+00
CS137	1.44E+05
H3	1.10E+04
I129	6.40E-02
MO93	1.50E-01
NB94	1.94E+01
NI59	1.14E+02
NI63	8.63E+04
NP237	2.52E-01
PD107	1.76E-01
PU238	3.34E+02
PU239	5.66E+02
PU240	2.60E+02
PU241	2.57E+04
PU242	2.14E-01
RA226	1.50E+01
RA228	5.78E+00
SE79	6.00E-01
SM151	7.52E+02
SN121M	3.00E+00
SN126	1.35E+00
SR90	8.79E+04
TC99	2.12E+01
TH232	3.00E-05
U232	2.49E-03
U233	6.43E-02
U234	2.47E+00
U235	2.16E-01

Structure P29-1	
Nuclide	**Activity (GBq)**
AG108M	5.90E+01
AM241	1.27E+01
AM243	6.27E-02
BE10	1.18E-02
C14	9.40E+02
CA41	2.95E-01
CL36	4.24E-02
CM242	2.64E-03
CM243	1.40E-03
CM244	3.43E+00
CO60	5.90E+04
CS135	2.41E-02
CS137	2.88E+03
H3	3.33E+02
I129	2.57E-03
MO93	5.90E-02
NB94	7.32E+00
NI59	5.59E+01
NI63	6.08E+04
NP237	1.67E-02
PD107	1.14E-03
PU238	3.28E+01
PU239	1.81E+01
PU240	1.22E+01
PU241	1.66E+03
PU242	1.08E-02
RA226	3.79E-02
SE79	2.36E-01
SM151	4.64E+00
SN121M	1.179E+00
SN126	5.306E-01
SR90	7.425E+02
TC99	2.531E-01
U232	5.282E-03
U234	1.917E+00
U235	7.595E-02
U236	4.267E-02
U238	1.603E+00
ZR93	9.529E-01

Structure P29-2	
Nuclide	**Activity (GBq)**
AG108M	1.73E+02
AM241	1.48E+02
AM243	1.39E+00
BE10	3.47E-02
C14	3.05E+03
CA41	8.67E-01
CL36	1.54E-01
CM242	1.05E+01
CM243	2.84E-03
CM244	5.10E+01
CO60	1.79E+05
CS135	3.93E-01
CS137	2.39E+04
H3	8.10E+02
I129	1.74E-02
MO93	1.73E-01
NB94	2.13E+01
NI59	1.91E+02
NI63	2.26E+05
NP237	1.44E+00
PD107	1.57E-02
PU238	1.04E+02
PU239	1.66E+02
PU240	9.10E+01
PU241	6.86E+03
PU242	3.34E-02
RA226	1.23E-06
SE79	6.94E-01
SM151	7.00E+01
SN121M	3.47E+00
SN126	1.56E+00
SR90	6.12E+03
TC99	2.59E+00
U232	3.59E-02
U234	3.93E+00
U235	1.24E-01
U236	2.83E-01
U238	3.62E+00
ZR93	8.57E-01

Structure P29-3	
Nuclide	Activity (GBq)
AG108M	1.76E+01
AM241	2.24E+03
AM243	3.09E+01
BE10	3.53E-03
C14	2.03E+03
CA41	8.81E-02
CL36	2.14E+02
CM242	2.28E+00
CM243	1.22E+01
CM244	1.93E+03
CO60	4.52E+05
CS135	1.00E+01
CS137	2.87E+05
H3	3.71E+04
I129	1.01E-01
MO93	1.62E-02
NB94	3.50E+00
NI59	2.51E+01
NI63	7.51E+04
NP237	8.24E-01
PD107	4.00E-01
PU238	1.21E+03
PU239	4.39E+02
PU240	4.67E+02
PU241	7.11E+04
PU242	1.48E-01
RA226	1.86E-01
SE79	7.05E-02
SM151	1.71E+03
SN121M	3.525E-01
SN126	1.586E-01
SR90	1.992E+05
TC99	4.580E+01
U232	4.016E-02
U234	2.514E+00
U235	5.282E-02
U236	3.204E-01
U238	1.611E+00
ZR93	6.341E-01

Structure P3	
Nuclide	Activity (GBq)
AG108M	6.45E+00
AM241	6.06E+00
BE10	1.29E-03
C14	3.26E+02
CA41	3.23E-02
CL36	6.45E-03
CO60	6.45E+03
CS135	8.72E-01
CS137	2.49E+04
H3	3.27E+02
I129	8.74E-03
MO93	6.45E-03
NB94	2.99E+00
NI59	5.86E+01
NI63	3.64E+03
NP237	5.42E-04
PD107	3.51E-02
PU238	2.16E+03
PU239	5.60E+03
PU240	6.13E+02
PU241	2.51E+05
SE79	2.58E-02
SM151	1.50E+02
SN121M	1.29E-01
SN126	5.81E-02
SR90	8.62E+03
TC99	4.00E+00
U234	1.50E+01
U235	6.73E-01
U238	1.50E+01
ZR93	8.19E-01

Structure P30-1	
Nuclide	Activity (GBq)
AG108M	5.08E+01
AM241	1.65E+03
AM243	9.48E+00
BE10	1.02E-02
C14	7.16E+02
CA41	2.54E-01
CL36	1.16E-01
CM242	9.13E-01
CM243	3.18E-01
CM244	6.54E+02
CO60	5.08E+04
CS135	5.66E+00
CS137	1.70E+05
H3	1.86E+03
I129	6.50E-02
MO93	5.08E-02
NB94	6.42E+00
NI59	4.02E+01
NI63	3.69E+04
NP237	1.72E-01
PD107	2.26E-01
PU238	3.55E+02
PU239	1.16E+03
PU240	2.38E+02
PU241	2.64E+04
PU242	4.44E-01
RA226	1.75E-02
SE79	2.03E-01
SM151	9.71E+02
SN121M	1.015E+00
SN126	4.569E-01
SR90	1.124E+05
TC99	2.635E+01
U232	1.226E-02
U234	6.246E+01
U235	3.174E+00
U236	1.051E-01
U238	6.196E+01
ZR93	1.480E+00

Structure P30-2	
Nuclide	Activity (GBq)
AG108M	1.62E+01
AM241	4.16E+02
AM243	2.85E+00
BE10	3.24E-03
C14	2.46E+02
CA41	8.10E-02
CL36	1.07E-02
CM242	4.11E-01
CM243	2.27E-01
CM244	2.07E+02
CO60	1.62E+04
CS135	1.76E+00
CS137	5.07E+04
H3	4.08E+02
I129	1.80E-02
MO93	1.62E-02
NB94	2.02E+00
NI59	1.43E+01
NI63	1.49E+04
NP237	5.01E-02
PD107	7.04E-02
PU238	9.38E+01
PU239	1.56E+02
PU240	3.52E+01
PU241	6.87E+03
PU242	7.88E-02
SE79	6.48E-02
SM151	3.02E+02
SN121M	3.24E-01
SN126	1.46E-01
SR90	3.50E+04
TC99	8.07E+00
U232	1.07E-02
U234	8.66E+00
U235	4.19E-01
U236	9.48E-02
U238	8.18E+00
ZR93	3.43E-01

Structure P31-1	
Nuclide	**Activity (GBq)**
AG108M	7.76E+01
AM241	2.19E+03
AM243	2.32E-01
BE10	1.55E-02
C14	4.75E+03
CA41	3.88E-01
CL36	3.15E+02
CM242	1.61E-02
CM243	1.12E-02
CM244	5.00E+01
CO60	7.77E+04
CS135	1.10E+00
CS137	4.03E+04
H3	4.31E+04
I129	2.02E-02
MO93	7.56E-02
NB94	2.06E+01
NI59	3.40E+02
NI63	7.59E+04
NP237	7.31E-03
PD107	4.41E-02
PU238	7.98E+02
PU239	2.36E+03
PU240	1.29E+03
PU241	3.13E+04
PU242	1.44E+00
RA226	1.30E-02
SE79	3.10E-01
SM151	1.90E+02
SN121M	1.552E+00
SN126	6.984E-01
SR90	1.381E+04
TC99	5.573E+00
U232	2.731E-02
U234	1.735E+01
U235	6.734E-01
U236	2.995E-01
U238	1.635E+01
ZR93	1.951E+00

Structure P31-2	
Nuclide	**Activity (GBq)**
AG108M	1.19E+02
AM241	3.04E+02
AM243	1.10E+00
BE10	2.39E-02
C14	2.64E+03
CA41	5.96E-01
CL36	4.53E+01
CM242	4.98E+00
CM243	9.77E-02
CM244	1.17E+02
CO60	1.19E+05
CS135	7.78E-01
CS137	3.24E+04
H3	1.26E+04
I129	1.86E-02
MO93	1.19E-01
NB94	1.73E+01
NI59	1.88E+02
NI63	1.42E+05
NP237	3.63E-01
PD107	3.15E-02
PU238	3.28E+02
PU239	4.91E+02
PU240	2.76E+02
PU241	2.23E+04
PU242	1.51E+00
RA226	1.72E-06
SE79	4.77E-01
SM151	1.36E+02
SN121M	2.39E+00
SN126	1.07E+00
SR90	1.00E+04
TC99	4.21E+00
U232	7.43E-02
U234	1.85E+01
U235	6.54E-01
U236	1.39E+00
U238	1.17E+01
ZR93	1.16E+00

Structure P31-3	
Nuclide	**Activity (GBq)**
AG108M	7.77E+01
AM241	1.47E+03
AM243	1.21E+01
BE10	1.55E-02
C14	1.40E+03
CA41	3.88E-01
CL36	3.30E+01
CM242	8.72E-02
CM243	7.56E-01
CM244	7.92E+02
CO60	7.77E+04
CS135	7.30E+00
CS137	2.30E+05
H3	6.33E+03
I129	9.59E-02
MO93	7.75E-02
NB94	1.01E+01
NI59	6.80E+01
NI63	5.56E+04
NP237	2.81E-01
PD107	2.92E-01
PU238	3.13E+02
PU239	2.44E+02
PU240	1.76E+02
PU241	2.52E+04
PU242	1.83E+00
SE79	3.11E-01
SM151	1.26E+03
SN121M	1.55E+00
SN126	6.990E-01
SR90	1.448E+05
TC99	3.469E+01
U232	6.922E-03
U234	1.868E+00
U235	8.368E-02
U236	4.561E-02
U238	1.599E+00
ZR93	2.268E+00

Structure P32	
Nuclide	**Activity (GBq)**
AG108M	2.19E+00
AM241	2.47E+02
AM243	2.89E+00
BE10	4.39E-04
C14	6.56E+01
CA41	1.10E-02
CL36	2.02E-03
CM242	8.38E-05
CM244	2.07E+02
CO60	2.19E+03
CS135	1.34E+00
CS137	3.83E+04
H3	3.48E+02
I129	1.34E-02
MO93	2.19E-03
NB94	3.27E-01
NI59	2.38E+00
NI63	7.55E+02
NP237	4.97E-02
PD107	5.39E-02
PU238	7.34E+01
PU239	2.31E+01
PU240	2.10E+01
PU241	3.94E+03
PU242	6.26E-02
RA226	1.09E-01
RA228	3.57E-01
SE79	8.78E-03
SM151	2.30E+02
SN121M	4.39E-02
SN126	1.97E-02
SR90	2.67E+04
TC99	6.14E+00
U232	3.19E-03
U233	8.00E-04
U234	1.64E+01
U235	6.78E-01
U236	2.10E-02

Structure P33-1	
Nuclide	**Activity (GBq)**
AG108M	3.28E+01
AM241	1.68E+02
AM243	5.67E-03
BE10	6.56E-03
C14	7.29E+02
CA41	1.64E-01
CL36	1.71E+01
CM242	2.02E-02
CM244	5.75E-01
CO60	3.28E+04
CS135	1.69E+00
CS137	4.92E+04
H3	2.48E+03
I129	1.78E-02
MO93	3.27E-02
NB94	5.93E+00
NI59	6.20E+01
NI63	1.24E+04
NP237	2.74E-01
PD107	6.91E-02
PU238	1.44E+02
PU239	1.59E+02
PU240	5.85E+01
PU241	8.73E+03
PU242	6.66E-02
RA226	1.91E-02
RA228	6.24E-02
SE79	1.31E-01
SM151	2.91E+02
SN121M	6.564E-01
SN126	2.954E-01
SR90	2.603E+03
TC99	7.841E+00
TH232	1.100E-03
U232	5.084E-03
U233	1.100E+00
U234	1.384E+01
U235	6.372E-01
U236	3.506E-01
U238	7.691E+00
ZR93	1.337E+00

Structure P33-2	
Nuclide	**Activity (GBq)**
AG108M	1.02E+00
AM241	1.14E+01
AM243	5.20E-02
BE10	2.04E-04
C14	1.39E+01
CA41	5.09E-03
CL36	1.02E-03
CM242	8.80E-06
CM244	3.81E+00
CO60	1.02E+03
CS135	6.08E-02
CS137	1.74E+03
H3	2.16E+01
I129	6.11E-04
MO93	1.02E-03
NB94	1.56E-01
NI59	1.13E+00
NI63	2.57E+02
NP237	1.74E-03
PD107	2.47E-03
PU238	1.81E+01
PU239	2.93E+01
PU240	2.07E+01
PU241	1.45E+03
PU242	1.59E-02
RA226	2.40E-06
SE79	4.07E-03
SM151	1.04E+01
SN121M	2.04E-02
SN126	9.16E-03
SR90	8.08E+02
TC99	2.79E-01
TH232	3.00E-03
U232	1.48E-02
U234	9.56E-01
U235	2.84E-02
U236	8.11E-02
U238	5.78E-01
ZR93	5.50E-02

Structure P34-1	
Nuclide	**Activity (GBq)**
AG108M	2.63E-01
AM241	1.83E+01
AM243	2.29E-03
BE10	5.26E-05
C14	3.42E+00
CA41	1.31E-03
CL36	2.63E-04
CM242	9.06E-05
CM244	6.39E-01
CO60	2.63E+02
CS135	3.13E-03
CS137	9.18E+01
H3	5.34E-01
I129	3.39E-05
MO93	2.63E-04
NB94	3.91E-02
NI59	2.66E-01
NI63	6.54E+01
NP237	8.08E-05
PD107	1.52E-04
PU238	1.30E+02
PU239	3.17E+01
PU240	3.36E+01
PU241	4.52E+03
PU242	9.60E-02
SE79	1.05E-03
SM151	5.45E-01
SN121M	5.26E-03
SN126	2.37E-03
SR90	6.986E+01
TC99	1.538E-02
U232	2.604E-02
U234	7.256E-01
U235	1.040E-02
U236	1.534E-01
U238	2.002E-01
ZR93	1.405E-02

Structure P34-2	
Nuclide	**Activity (GBq)**
AG108M	4.18E-02
AM241	6.45E+02
AM243	3.14E+00
BE10	8.36E-06
C14	2.09E+00
CA41	2.09E-04
CL36	4.18E-05
CM243	2.51E+00
CM244	1.55E+02
CO60	4.18E+01
CS135	2.62E+00
CS137	7.48E+04
H3	4.49E+02
I129	2.62E-02
MO93	4.18E-05
NB94	2.09E-02
NI59	4.18E-01
NI63	2.51E+01
NP237	1.05E-01
PD107	1.05E-01
PU238	1.88E+02
PU239	8.27E+01
PU240	8.37E+01
PU241	1.44E+04
PU242	1.80E-01
SE79	1.67E-04
SM151	4.49E+02
SN121M	8.36E-04
SN126	3.76E-04
SR90	5.36E+04
TC99	1.20E+01
TH232	3.00E-06
U232	2.99E-03
U234	1.12E+00
U235	4.84E-02
U236	1.83E-01
U238	6.50E-01

Structure P4	
Nuclide	**Activity (GBq)**
AG108M	3.60E+00
AM241	6.26E-02
BE10	7.20E-04
C14	1.24E+02
CA41	1.80E-02
CL36	3.60E-03
CO60	3.60E+03
CS135	8.31E-01
CS137	2.38E+04
H3	1.68E+02
I129	8.33E-03
MO93	3.60E-03
NB94	1.10E+00
NI59	1.80E+01
NI63	1.46E+03
NP237	6.14E-04
PD107	3.35E-02
PU238	1.02E+03
PU239	1.85E+03
PU240	9.44E+01
PU241	9.32E+04
SE79	1.44E-02
SM151	1.43E+02
SN121M	7.20E-02
SN126	3.24E-02
SR90	4.46E+03
TC99	3.81E+00
U234	1.18E+01
U235	5.46E-01
U238	1.177E+01
ZR93	6.549E-01

Structure P5	
Nuclide	**Activity (GBq)**
AG108M	3.07E+02
AM241	1.67E+00
BE10	6.15E-02
C14	1.51E+04
CA41	1.54E+00
CL36	3.07E-01
CO60	3.07E+05
CS135	1.28E+01
CS137	3.66E+05
H3	1.11E+04
I129	1.28E-01
MO93	3.07E-01
NB94	1.51E+02
NI59	3.01E+03
NI63	1.82E+05
NP237	2.71E-03
PD107	5.14E-01
PU238	1.40E+03
PU239	6.95E+03
PU240	1.54E+02
PU241	1.26E+05
RA226	2.14E+02
RA228	1.22E+03
SE79	1.23E+00
SM151	2.20E+03
SN121M	6.15E+00
SN126	2.77E+00
SR90	3.58E+03
TC99	5.86E+01
TH232	1.05E+01
U234	6.20E+01

Structure P5bis	
Nuclide	**Activity (GBq)**
AG108M	3.33E+01
AM241	2.67E-04
BE10	6.66E-03
C14	1.66E+03
CA41	1.66E-01
CL36	3.33E-02
CO60	3.33E+04
CS135	2.96E+00
CS137	8.45E+04
H3	7.53E+03
I129	2.96E-02
MO93	3.33E-02
NB94	1.66E+01
NI59	3.33E+02
NI63	2.00E+04
NP237	1.23E-05
PD107	1.18E-01
PU238	3.20E-03
PU239	1.19E+02
PU240	5.87E-04
PU241	9.09E+02
SE79	1.33E-01
SM151	5.07E+02
SN121M	6.66E-01
SN126	3.00E-01
SR90	5.67E+01
TC99	1.35E+01
U234	2.04E+00
U235	9.16E-02
U238	2.040E+00
ZR93	3.350E+00

Structure P6	
Nuclide	**Activity (GBq)**
AG108M	3.08E+00
AM241	7.13E-03
BE10	6.16E-04
C14	1.48E+02
CA41	1.54E-02
CL36	3.08E-03
CO60	3.08E+03
CS135	3.70E-01
CS137	1.06E+04
H3	4.94E+01
I129	3.71E-03
MO93	3.08E-03
NB94	1.38E+00
NI59	2.66E+01
NI63	1.69E+03
NP237	2.44E-04
PD107	1.49E-02
PU238	7.52E-01
PU239	1.07E+03
PU240	8.94E+01
PU241	4.56E+03
RA226	1.30E+02
RA228	3.00E+02
SE79	1.23E-02
SM151	6.34E+01
SN121M	6.16E-02
SN126	2.77E-02
SR90	3.44E+02
TC99	1.69E+00
TH232	6.18E+01
U234	7.52E+02

Structure P7	
Nuclide	**Activity (GBq)**
AG108M	1.64E+02
AM241	1.92E+01
BE10	3.28E-02
C14	8.12E+03
CA41	8.21E-01
CL36	1.64E-01
CO60	1.64E+05
CS135	6.73E+00
CS137	1.92E+05
H3	2.75E+03
I129	6.73E-02
MO93	1.64E-01
NB94	8.12E+01
NI59	1.62E+03
NI63	9.76E+04
NP237	4.56E-04
PD107	2.69E-01
PU238	6.05E+02
PU239	2.90E+03
PU240	1.02E+02
PU241	5.15E+04
RA226	8.49E+01
RA228	4.85E+02
SE79	6.57E-01
SM151	1.15E+03
SN121M	3.28E+00
SN126	1.48E+00
SR90	1.66E+03
TC99	3.08E+01
TH232	4.167E+00
U234	1.858E+01
U235	7.503E+00
U238	1.858E+01
ZR93	1.206E+01

Structure P8	
Nuclide	**Activity (GBq)**
AG108M	1.59E+02
AM241	3.57E+01
BE10	3.18E-02
C14	7.90E+03
CA41	7.96E-01
CL36	1.70E-01
CM242	6.48E-01
CM244	1.68E+00
CO60	1.59E+05
CS135	1.25E+01
CS137	3.58E+05
H3	3.66E+04
I129	1.26E-01
MO93	1.59E-01
NB94	7.84E+01
NI59	1.56E+03
NI63	9.58E+04
NP237	3.93E-03
PD107	5.02E-01
PU238	7.16E+02
PU239	3.74E+03
PU240	7.47E+02
PU241	1.42E+05
PU242	3.01E-01
RA226	9.11E+01
RA228	8.53E+02
SE79	6.37E-01
SM151	2.14E+03
SN121M	3.18E+00
SN126	1.43E+00
SR90	6.57E+03
TC99	5.72E+01
TH232	4.47E+00
U234	1.61E+02

Structure P9	
Nuclide	Activity (GBq)
AG108M	3.81E+02
AM241	7.59E+01
AM243	4.70E-02
BE10	7.62E-02
C14	1.86E+04
CA41	1.90E+00
CL36	4.05E-01
CM242	4.99E+00
CM243	7.80E-04
CM244	5.60E-01
CO60	3.81E+05
CS135	1.62E+01
CS137	4.67E+05
H3	1.76E+04
I129	1.66E-01
MO93	3.81E-01
NB94	1.85E+02
NI59	3.69E+03
NI63	2.34E+05
NP237	5.66E-03
PD107	6.50E-01
PU238	1.27E+03
PU239	5.61E+03
PU240	3.34E+02
PU241	1.19E+05
PU242	8.13E-02
RA226	2.01E+02
RA228	1.43E+03
SE79	1.52E+00
SM151	2.782E+03
SN121M	7.616E+00
SN126	3.427E+00
SR90	1.040E+04
TC99	7.439E+01
TH232	1.025E+01
U232	2.514E-03
U234	1.598E+02
U235	7.361E+00
U236	1.830E-02
U238	1.597E+02
ZR93	2.761E+01

Structure PTW	
Nuclide	Activity (GBq)
AG108M	5.79E-01
AM241	1.51E+02
AM243	2.75E-01
BE10	1.16E-04
C14	1.23E+01
CA41	2.90E-03
CL36	5.79E-04
CM242	2.66E-02
CM243	1.67E-01
CM244	2.97E+01
CO60	5.79E+02
CS135	3.22E-01
CS137	9.21E+03
H3	5.60E+01
I129	3.22E-03
MO93	5.79E-04
NB94	1.31E-01
NI59	1.74E+00
NI63	1.89E+02
NP237	8.82E-03
PD107	1.29E-02
PU238	1.91E+02
PU239	1.78E+02
PU240	7.04E+01
PU241	8.93E+03
PU242	1.81E-01
SE79	2.32E-03
SM151	5.52E+01
SN121M	1.16E-02
SN126	5.21E-03
SR90	6.20E+03
TC99	1.47E+00
U232	5.74E-04
U234	3.09E+01
U235	1.42E+00
U236	8.59E-03
U238	3.08E+01
ZR93	5.24E-02

Structure T13-1	
Nuclide	**Activity (GBq)**
AG108M	8.97E+00
AM241	1.60E+03
AM243	4.98E+00
BE10	1.79E-03
C14	1.61E+03
CA41	4.49E-02
CL36	1.77E+02
CM242	2.28E+02
CM244	6.34E+02
CO60	9.31E+03
CS135	9.52E-01
CS137	2.94E+04
H3	2.34E+04
I129	9.58E-03
MO93	7.82E-03
NB94	1.79E+00
NI59	1.94E+01
NI63	3.26E+03
NP237	2.03E-03
PD107	3.87E-02
PU238	7.58E+03
PU239	6.72E+03
PU240	2.69E+03
PU241	1.22E+06
PU242	6.68E-01
SE79	3.59E-02
SM151	1.63E+02
SN121M	1.79E-01
SN126	8.08E-02
SR90	1.435E+04
TC99	4.378E+00
U234	9.895E-01
U235	4.772E-01
U238	9.895E-01
ZR93	4.232E-01

Structure T13-2	
Nuclide	**Activity (GBq)**
AG108M	2.21E+01
AM241	3.71E+02
AM243	7.04E-01
BE10	4.41E-03
C14	1.03E+03
CA41	1.10E-01
CL36	2.41E+01
CM242	2.89E+01
CM244	8.29E+01
CO60	2.21E+04
CS135	9.40E-01
CS137	3.43E+04
H3	3.51E+03
I129	1.73E-02
MO93	2.19E-02
NB94	7.85E+00
NI59	1.42E+02
NI63	1.43E+04
NP237	9.08E-01
PD107	9.28E-02
PU238	1.95E+03
PU239	2.79E+03
PU240	1.19E+03
PU241	6.27E+05
PU242	5.95E-01
SE79	8.83E-02
SM151	1.81E+02
SN121M	4.41E-01
SN126	1.99E-01
SR90	1.57E+04
TC99	6.71E+00
U234	9.35E+01
U235	4.17E+00
U238	8.44E+01
ZR93	5.14E-01

Structure T13-3	
Nuclide	Activity (GBq)
AG108M	9.12E+00
AM241	4.33E-01
AM243	3.35E-04
BE10	1.82E-03
C14	2.19E+03
CA41	4.56E-02
CL36	2.65E+02
CM242	1.56E-04
CO60	9.12E+03
CS135	3.01E-02
CS137	1.00E+04
H3	3.45E+04
I129	1.00E-02
MO93	7.40E-03
NB94	1.37E+00
NI59	7.73E+00
NI63	3.76E+03
NP237	2.95E-01
PD107	9.82E-02
PU238	5.16E+00
PU239	6.09E-01
PU240	9.46E-01
PU241	2.46E+02
PU242	2.16E-05
SE79	3.65E-02
SM151	3.94E+01
SN121M	1.82E-01
SN126	8.21E-02
SR90	1.54E+02
TC99	4.138E+00
U232	8.420E-04
U234	7.124E-02
U235	1.839E-03
U236	9.806E-03
U238	3.671E-02
ZR93	2.948E-01

Structure T19	
Nuclide	Activity (GBq)
AG108M	7.00E+01
AM241	1.22E+02
AM243	3.34E+00
BE10	1.40E-02
C14	1.34E+03
CA41	3.50E-01
CL36	1.11E+00
CM242	1.83E-01
CM244	9.53E+01
CO60	7.00E+04
CS135	4.71E-01
CS137	3.50E+04
H3	1.40E+03
I129	2.76E-02
MO93	7.00E-02
NB94	9.93E+00
NI59	1.04E+02
NI63	8.17E+04
NP237	4.23E-01
PD107	1.57E-01
PU238	1.97E+02
PU239	4.68E+02
PU240	1.46E+02
PU241	4.27E+04
PU242	3.31E-02
SE79	2.80E-01
SM151	1.31E+02
SN121M	1.40E+00
SN126	6.30E-01
SR90	5.23E+03
TC99	8.39E+00
U234	3.03E+01
U235	1.47E+00
U238	3.64E+01
ZR93	8.39E-01

Structure T20	
Nuclide	**Activity (GBq)**
AG108M	6.67E+01
AM241	3.42E+02
AM243	2.20E+00
BE10	1.33E-02
C14	2.13E+03
CA41	3.34E-01
CL36	1.31E+00
CM242	1.17E+01
CM244	1.09E+02
CO60	6.70E+04
CS135	2.15E-01
CS137	3.56E+04
H3	9.60E+02
I129	3.28E-02
MO93	6.67E-02
NB94	1.82E+01
NI59	3.07E+02
NI63	6.53E+04
NP237	7.12E+00
PD107	1.57E-01
PU238	3.96E+02
PU239	1.71E+03
PU240	5.50E+02
PU241	2.13E+05
PU242	6.83E+00
SE79	2.67E-01
SM151	9.24E+01
SN121M	1.33E+00
SN126	6.01E-01
SR90	1.243E+03
TC99	8.031E+00
U232	6.660E+00
U234	1.081E+01
U235	4.036E-01
U238	4.828E+00
ZR93	3.969E-01

Structure T21	
Nuclide	**Activity (GBq)**
AG108M	1.21E+02
AM241	3.00E+02
AM243	8.66E+00
BE10	2.42E-02
C14	2.83E+03
CA41	6.06E-01
CL36	5.81E+00
CM242	1.01E+01
CM244	5.01E+01
CO60	1.21E+05
CS135	5.83E-01
CS137	5.33E+04
H3	2.43E+03
I129	4.47E-02
MO93	1.21E-01
NB94	2.47E+01
NI59	3.29E+02
NI63	8.83E+04
NP237	3.17E-01
PD107	1.26E-01
PU238	3.25E+03
PU239	3.01E+03
PU240	1.59E+03
PU241	2.99E+05
PU242	4.76E-01
RA226	1.13E+02
SE79	4.85E-01
SM151	1.42E+02
SN121M	2.42E+00
SN126	1.09E+00
SR90	5.05E+03
TC99	8.57E+00
TH232	5.77E+00
U234	3.95E+00
U235	9.26E-04
U236	9.26E-04

Structure T22	
Nuclide	Activity (GBq)
AG108M	2.43E+01
AM241	3.60E+01
AM243	1.05E-01
BE10	4.85E-03
C14	4.89E+02
CA41	1.21E-01
CL36	2.24E+00
CM242	2.79E+00
CM244	7.79E+00
CO60	2.43E+04
CS135	1.25E-01
CS137	2.42E+04
H3	7.18E+02
I129	2.31E-02
MO93	2.42E-02
NB94	3.80E+00
NI59	3.79E+01
NI63	1.86E+04
NP237	1.08E+00
PD107	1.93E-01
PU238	8.39E+01
PU239	4.62E+02
PU240	9.83E+01
PU241	5.20E+04
PU242	4.86E-02
SE79	9.70E-02
SM151	8.84E+01
SN121M	4.85E-01
SN126	2.18E-01
SR90	7.087E+02
TC99	8.494E+00
U232	6.303E-03
U234	2.016E+01
U235	9.584E-01
U236	7.554E-02
U238	1.737E+01
ZR93	6.378E-01

Structure T23	
Nuclide	Activity (GBq)
AG108M	1.90E+01
AM241	5.08E+02
AM243	6.45E+00
BE10	3.79E-03
C14	6.35E+02
CA41	9.48E-02
CL36	4.28E+01
CM242	6.40E+00
CM244	2.70E+01
CO60	1.90E+04
CS135	1.13E-01
CS137	1.24E+04
H3	6.16E+03
I129	1.08E-02
MO93	1.87E-02
NB94	2.52E+00
NI59	1.97E+01
NI63	1.69E+04
NP237	8.87E-02
PD107	3.28E-02
PU238	7.99E+02
PU239	2.88E+03
PU240	1.21E+03
PU241	1.66E+05
PU242	7.00E-01
RA226	2.50E+02
RA228	1.72E+03
SE79	7.59E-02
SM151	3.07E+01
SN121M	3.79E-01
SN126	1.71E-01
SR90	9.65E+02
TC99	2.09E+00
TH232	8.30E+00
U232	1.25E-02
U234	1.69E+01
U235	1.16E+00

Structure T24-0	
Nuclide	**Activity (GBq)**
AG108M	5.30E+01
AM241	2.78E+02
AM243	2.32E+00
BE10	1.06E-02
C14	9.76E+02
CA41	2.65E-01
CL36	1.15E-01
CM242	5.26E+01
CM244	8.50E+01
CO60	5.30E+04
CS135	2.69E-01
CS137	2.01E+04
H3	9.41E+02
I129	1.59E-02
MO93	5.30E-02
NB94	7.23E+00
NI59	7.19E+01
NI63	6.26E+04
NP237	9.56E-02
PD107	4.14E-02
PU238	1.98E+03
PU239	2.43E+03
PU240	1.14E+03
PU241	5.12E+05
PU242	1.30E+00
SE79	2.12E-01
SM151	5.90E+01
SN121M	1.06E+00
SN126	4.77E-01
SR90	3.026E+03
TC99	3.085E+00
U234	2.902E+01
U235	1.493E+00
U236	6.838E-04
U238	2.911E+01
ZR93	5.356E-01

Structure T24-1	
Nuclide	**Activity (GBq)**
AG108M	2.78E-01
AM241	1.67E+01
AM243	1.02E-01
BE10	5.57E-05
C14	7.02E+00
CA41	1.39E-03
CL36	8.41E-03
CM242	2.26E-01
CM244	1.03E+00
CO60	2.78E+02
CS135	5.29E-03
CS137	1.03E+03
H3	1.71E+01
I129	9.88E-04
MO93	2.78E-04
NB94	5.63E-02
NI59	7.09E-01
NI63	1.49E+02
NP237	1.02E+00
PD107	1.64E-03
PU238	3.70E+01
PU239	4.29E+01
PU240	3.95E+00
PU241	3.07E+03
PU242	4.96E-03
RA226	2.51E+02
RA228	1.65E+03
SE79	1.11E-03
SM151	1.57E+00
SN121M	5.57E-03
SN126	2.50E-03
SR90	1.82E+01
TC99	1.29E-01
TH232	1.09E+01
U233	1.50E-03
U234	6.65E+00

Structure T24-2	
Nuclide	Activity (GBq)
AG108M	4.99E+01
AM241	7.85E+01
AM243	5.74E-01
BE10	9.99E-03
C14	9.32E+02
CA41	2.50E-01
CL36	1.20E-01
CM242	2.21E+00
CM243	1.04E-03
CM244	3.45E+00
CO60	5.00E+04
CS135	6.87E-02
CS137	1.22E+04
H3	1.11E+03
I129	1.15E-02
MO93	4.99E-02
NB94	6.51E+00
NI59	5.95E+01
NI63	5.80E+04
NP237	7.26E-01
PD107	5.30E-03
PU238	2.95E+02
PU239	3.46E+02
PU240	2.02E+02
PU241	2.82E+04
PU242	2.40E-01
RA226	4.48E-02
SE79	2.00E-01
SM151	1.48E+01
SN121M	9.989E-01
SN126	4.495E-01
SR90	7.459E+02
TC99	1.042E+00
TH232	4.570E-03
U232	5.966E-04
U234	7.237E+00
U235	6.754E-01
U236	2.072E-02
U238	1.287E+01
ZR93	5.258E-01

Structure T25-1	
Nuclide	Activity (GBq)
AG108M	1.75E+00
AM241	1.17E+02
BE10	3.49E-04
C14	3.33E+01
CA41	8.73E-03
CL36	1.66E-03
CM242	8.76E+00
CM244	3.08E+01
CO60	1.75E+03
CS135	5.39E-02
CS137	1.70E+03
H3	2.79E+01
I129	7.12E-04
MO93	1.75E-03
NB94	2.38E-01
NI59	2.54E+00
NI63	2.32E+03
NP237	7.90E-04
PD107	2.40E-03
PU238	2.33E+02
PU239	6.77E+02
PU240	2.05E+02
PU241	9.63E+04
PU242	8.97E-02
SE79	6.98E-03
SM151	9.35E+00
SN121M	3.49E-02
SN126	1.57E-02
SR90	4.30E+02
TC99	2.65E-01
U234	1.09E-01
ZR93	2.12E-02

Structure T25-2	
Nuclide	**Activity (GBq)**
AG108M	1.50E-01
AM241	4.05E+00
AM243	4.54E-02
BE10	3.01E-05
C14	3.73E+00
CA41	7.52E-04
CL36	1.50E-04
CM242	1.58E-01
CM244	1.97E+00
CO60	1.50E+02
CS135	1.53E-03
CS137	4.72E+01
H3	9.24E+00
I129	1.89E-05
MO93	1.50E-04
NB94	3.00E-02
NI59	3.46E-01
NI63	4.50E+01
NP237	1.22E-03
PD107	9.73E-05
PU238	1.31E+01
PU239	6.01E+00
PU240	3.35E+00
PU241	7.89E+02
PU242	2.24E-03
SE79	6.02E-04
SM151	2.76E-01
SN121M	3.01E-03
SN126	1.35E-03
SR90	1.630E+01
TC99	8.494E-03
TH232	3.700E-05
U234	2.091E+00
U235	7.956E-02
U236	1.623E-03
U238	8.751E-01
ZR93	7.807E-03

Structure T26	
Nuclide	**Activity (GBq)**
AG108M	1.01E+01
AM241	8.39E+00
AM243	7.51E-02
BE10	2.02E-03
C14	1.80E+02
CA41	5.05E-02
CL36	3.12E-02
CM242	8.20E-01
CM244	2.44E+00
CO60	1.01E+04
CS135	1.36E-02
CS137	3.26E+03
H3	2.30E+02
I129	3.18E-03
MO93	1.01E-02
NB94	1.24E+00
NI59	1.08E+01
NI63	1.28E+04
NP237	5.32E-02
PD107	1.90E-03
PU238	3.54E+01
PU239	3.11E+02
PU240	1.00E+01
PU241	5.90E+03
PU242	1.28E-03
RA226	3.17E+02
RA228	8.40E+02
SE79	4.04E-02
SM151	3.39E+00
SN121M	2.02E-01
SN126	9.09E-02
SR90	7.12E+01
TC99	2.89E-01
TH232	1.37E+01
U232	3.57E-03
U233	1.90E-04
U234	6.87E+00

Structure T27	
Nuclide	**Activity (GBq)**
AG108M	1.85E+01
AM241	5.19E+01
AM243	1.63E-04
BE10	3.69E-03
C14	3.22E+02
CA41	9.23E-02
CL36	2.64E-02
CM242	4.25E-02
CM244	4.93E+01
CO60	1.85E+04
CS135	2.43E-02
CS137	3.35E+03
H3	2.29E+02
I129	3.06E-03
MO93	1.85E-02
NB94	2.26E+00
NI59	1.80E+01
NI63	2.10E+04
NP237	2.47E+01
PD107	7.67E-03
PU238	7.60E+01
PU239	8.64E+02
PU240	1.51E+02
PU241	1.20E+04
PU242	2.47E+01
RA226	2.21E+02
RA228	6.82E+02
SE79	7.38E-02
SM151	6.96E+00
SN121M	3.692E-01
SN126	1.661E-01
SR90	2.428E+02
TC99	5.133E-01
TH232	1.253E+01
U232	2.464E+01
U234	3.848E+00
U235	1.815E-01
U238	3.858E+00
ZR93	2.210E-01

Structure T28-1	
Nuclide	**Activity (GBq)**
AG108M	1.57E+01
AM241	2.29E+01
AM243	9.76E-01
BE10	3.14E-03
C14	2.77E+02
CA41	7.85E-02
CL36	2.33E-02
CM242	1.45E+00
CM243	8.76E-05
CM244	2.32E+00
CO60	1.57E+04
CS135	5.14E-02
CS137	3.47E+03
H3	1.02E+02
I129	2.64E-03
MO93	1.57E-02
NB94	1.94E+00
NI59	1.73E+01
NI63	2.02E+04
NP237	5.53E-01
PD107	2.18E-03
PU238	1.67E+02
PU239	1.55E+02
PU240	1.00E+02
PU241	1.37E+04
PU242	1.46E-01
RA226	4.12E+02
RA228	2.81E+03
SE79	6.28E-02
SM151	9.27E+00
SN121M	3.14E-01
SN126	1.41E-01
SR90	7.65E+02
TC99	3.64E-01
TH232	7.12E+01
U232	5.57E-03
U234	6.16E+01
U235	2.83E+00
U236	1.11E-01

Structure T28-2	
Nuclide	Activity (GBq)
AG108M	1.09E+02
AM241	3.62E+01
AM243	1.85E-01
BE10	2.17E-02
C14	1.77E+03
CA41	5.43E-01
CL36	6.77E-02
CM242	1.06E-01
CM244	1.73E+00
CO60	1.09E+05
CS135	1.52E-02
CS137	4.19E+03
H3	1.95E+02
I129	4.14E-03
MO93	1.09E-01
NB94	1.33E+01
NI59	1.04E+02
NI63	1.21E+05
NP237	2.89E-01
PD107	8.25E-04
PU238	8.01E+01
PU239	1.45E+02
PU240	5.19E+01
PU241	3.91E+03
PU242	3.86E-02
RA226	3.70E+02
RA228	2.19E+03
SE79	4.34E-01
SM151	3.47E+00
SN121M	2.172E+00
SN126	9.774E-01
SR90	7.557E+02
TC99	3.112E-01
TH232	6.619E+01
U232	2.917E-02
U234	4.553E+01
U235	2.010E+00
U236	2.757E-01
U238	4.425E+01
ZR93	1.387E+00

Structure T28-3	
Nuclide	Activity (GBq)
AG108M	7.49E+00
AM241	2.95E+01
AM243	1.14E-02
BE10	1.50E-03
C14	1.00E+02
CA41	3.74E-02
CL36	9.56E-03
CM242	5.72E-02
CM243	7.81E-05
CM244	6.16E-01
CO60	7.49E+03
CS135	2.22E-02
CS137	1.02E+03
H3	5.86E+01
I129	6.31E-04
MO93	7.49E-03
NB94	9.77E-01
NI59	5.80E+00
NI63	4.23E+03
NP237	3.46E-04
PD107	9.15E-04
PU238	1.65E+01
PU239	3.53E+01
PU240	2.35E+01
PU241	1.93E+03
PU242	1.83E-02
RA226	7.37E+01
RA228	5.14E+02
SE79	2.99E-02
SM151	3.90E+00
SN121M	1.50E-01
SN126	6.74E-02
SR90	3.96E+02
TC99	1.27E-01
TH232	5.27E+00
U232	7.72E-03
U234	2.60E+00
U235	1.01E-01
U236	6.07E-02
U238	2.35E+00

Structure T29-1	
Nuclide	Activity (GBq)
AG108M	1.93E+01
AM241	2.04E+00
AM243	2.28E-03
BE10	3.87E-03
C14	3.46E+02
CA41	9.66E-02
CL36	1.08E-02
CM242	1.81E-03
CM244	6.02E-02
CO60	1.93E+04
CS135	9.36E-03
CS137	1.22E+03
H3	4.95E+01
I129	1.10E-03
MO93	1.93E-02
NB94	2.33E+00
NI59	2.11E+01
NI63	2.66E+04
NP237	1.76E-03
PD107	3.99E-04
PU238	1.64E+00
PU239	3.75E+00
PU240	2.00E+00
PU241	4.72E+01
SE79	7.73E-02
SM151	1.81E+00
SN121M	3.87E-01
SN126	1.74E-01
SR90	1.21E+02
TC99	1.031E-01
U232	1.533E-03
U234	4.084E+00
U235	1.827E-01
U236	1.393E-02
U238	4.597E+00
ZR93	3.025E-02

Structure T29-2	
Nuclide	Activity (GBq)
AG108M	1.07E+01
AM241	1.60E+01
AM243	2.17E-03
BE10	2.14E-03
C14	1.67E+02
CA41	5.34E-02
CL36	9.59E-03
CM242	5.32E-04
CM243	2.66E-04
CM244	4.32E-01
CO60	1.07E+04
CS135	2.81E-02
CS137	1.32E+03
H3	6.49E+03
I129	8.30E-04
MO93	1.07E-02
NB94	1.33E+00
NI59	9.76E+00
NI63	1.02E+04
NP237	4.41E-04
PD107	1.22E-03
PU238	2.13E+01
PU239	4.13E+01
PU240	2.31E+01
PU241	1.73E+03
PU242	1.05E-02
RA226	1.56E+02
RA228	1.08E+03
SE79	4.27E-02
SM151	4.96E+00
SN121M	2.14E-01
SN126	9.61E-02
SR90	5.74E+02
TC99	1.64E-01
TH232	1.06E+01
U232	2.81E-02

Structure T29-3	
Nuclide	**Activity (GBq)**
AG108M	9.60E+01
AM241	9.02E+00
AM243	3.75E-02
BE10	1.92E-02
C14	1.55E+03
CA41	4.80E-01
CL36	1.27E-01
CM242	1.15E-02
CM243	1.34E-03
CM244	1.69E+00
CO60	9.60E+04
CS135	9.24E-02
CS137	1.16E+04
H3	8.61E+02
I129	1.05E-02
MO93	9.60E-02
NB94	1.20E+01
NI59	9.31E+01
NI63	1.01E+05
NP237	1.68E-02
PD107	3.78E-03
PU238	1.15E+02
PU239	8.83E+01
PU240	5.37E+01
PU241	5.97E+03
PU242	7.82E-02
RA226	1.73E+02
RA228	1.21E+03
SE79	3.84E-01
SM151	1.777E+01
SN121M	1.921E+00
SN126	8.642E-01
SR90	1.689E+03
TC99	9.870E-01
TH232	1.245E+01
U232	3.719E-02
U233	2.000E-04
U234	1.210E+01
U235	4.489E-01
U236	3.227E-01
U238	1.023E+01
ZR93	1.472E+00

Structure T30-1	
Nuclide	**Activity (GBq)**
AG108M	1.79E+01
AM241	1.68E+01
AM243	1.83E-02
BE10	3.58E-03
C14	2.95E+02
CA41	8.95E-02
CL36	1.79E-02
CM242	8.21E-02
CM244	1.28E+00
CO60	1.24E+05
CS135	8.37E-02
CS137	3.40E+03
H3	2.43E+02
I129	1.90E-03
MO93	1.79E-02
NB94	2.42E+00
NI59	1.57E+01
NI63	3.61E+04
NP237	1.19E-02
PD107	3.51E-03
PU238	9.81E+00
PU239	2.75E+01
PU240	1.02E+01
PU241	4.42E+02
PU242	9.12E-04
RA226	3.91E+02
RA228	2.73E+03
SE79	7.16E-02
SM151	1.46E+01
SN121M	3.58E-01
SN126	1.61E-01
SR90	4.52E+02
TC99	4.51E-01
TH232	3.22E+01
U232	2.25E-04
U233	9.99E-07
U234	8.18E+00
U235	3.66E-01
U236	9.42E-04
U238	7.67E+00
ZR93	3.59E-01

Structure T30-2	
Nuclide	**Activity (GBq)**
AG108M	1.64E+01
AM241	7.54E+01
AM243	1.23E-01
BE10	3.27E-03
C14	1.82E+02
CA41	8.18E-02
CL36	1.64E-02
CM242	3.70E-02
CM244	7.96E+00
CO60	2.71E+04
CS135	3.46E-01
CS137	9.88E+03
H3	2.57E+03
I129	3.46E-03
MO93	1.64E-02
NB94	2.14E+00
NI59	8.69E+00
NI63	5.41E+03
NP237	1.77E-03
PD107	1.38E-02
PU238	6.16E+01
PU239	1.32E+02
PU240	7.81E+01
PU241	3.86E+03
PU242	3.53E-02
RA226	3.85E-07
SE79	6.54E-02
SM151	5.92E+01
SN121M	3.27E-01
SN126	1.472E-01
SR90	1.508E+03
TC99	1.581E+00
U234	1.703E+00
U235	6.966E-02
U236	4.085E-03
U238	1.619E+00
ZR93	8.176E-01

Structure T32	
Nuclide	**Activity (GBq)**
AG108M	1.24E+01
AM241	4.28E+02
AM243	7.13E-01
BE10	2.48E-03
C14	9.88E+02
CA41	6.19E-02
CL36	9.64E+01
CM242	4.15E-04
CM243	2.66E-04
CM244	9.53E+01
CO60	1.24E+04
CS135	7.58E-01
CS137	2.45E+04
H3	1.28E+04
I129	1.02E-02
MO93	1.18E-02
NB94	1.66E+00
NI59	1.49E+01
NI63	1.45E+04
NP237	1.33E-01
PD107	3.03E-02
PU238	4.68E+02
PU239	4.09E+02
PU240	2.25E+02
PU241	7.24E+04
PU242	8.38E-01
RA226	2.21E-02
RA228	7.22E-02
SE79	4.95E-02
SM151	1.30E+02
SN121M	2.48E-01
SN126	1.11E-01
SR90	1.40E+04
TC99	3.62E+00
U232	1.26E-02
U234	2.34E+00
U235	8.98E-02

Structure T33-0	
Nuclide	**Activity (GBq)**
AG108M	2.17E+01
AM241	4.01E+01
AM243	3.61E-02
BE10	4.34E-03
C14	3.80E+02
CA41	1.08E-01
CL36	1.04E-02
CM242	3.53E-02
CM244	7.49E+00
CO60	2.40E+05
CS135	9.33E-02
CS137	3.03E+03
H3	7.51E+02
I129	1.32E-03
MO93	2.17E-02
NB94	3.02E+00
NI59	2.08E+01
NI63	5.44E+04
NP237	2.30E-03
PD107	3.97E-03
PU238	3.06E+01
PU239	9.35E+01
PU240	4.44E+01
PU241	1.15E+03
PU242	1.84E-03
RA226	9.08E-07
SE79	8.68E-02
SM151	1.62E+01
SN121M	4.34E-01
SN126	1.952E-01
SR90	1.551E+03
TC99	4.576E-01
U232	5.066E-04
U234	1.138E+00
U235	5.032E-02
U236	1.471E-02
U238	4.833E+00
ZR93	3.427E-01

Structure T33-1	
Nuclide	**Activity (GBq)**
AG108M	7.42E+00
AM241	9.58E+02
AM243	7.02E+00
BE10	1.48E-03
C14	1.69E+02
CA41	3.71E-02
CL36	4.82E+00
CM242	1.41E-01
CM243	3.96E-01
CM244	7.12E+02
CO60	7.42E+03
CS135	4.59E+00
CS137	1.32E+05
H3	5.52E+03
I129	4.63E-02
MO93	7.39E-03
NB94	9.38E-01
NI59	8.44E+00
NI63	9.15E+03
NP237	1.06E-01
PD107	1.84E-01
PU238	3.74E+02
PU239	2.94E+02
PU240	1.98E+02
PU241	2.27E+04
PU242	1.33E-01
RA226	2.20E-08
SE79	2.97E-02
SM151	7.88E+02
SN121M	1.48E-01
SN126	6.68E-02
SR90	8.97E+04
TC99	2.10E+01
TH232	1.00E+00
U232	1.97E-03
U234	3.07E+00
U235	1.26E-01
U236	1.83E-02

Structure T33-2	
Nuclide	Activity (GBq)
AG108M	1.39E+01
AM241	6.28E+02
AM243	5.79E+00
BE10	2.78E-03
C14	1.79E+02
CA41	6.95E-02
CL36	1.06E-02
CM242	7.91E-02
CM244	4.24E+02
CO60	2.49E+04
CS135	3.08E+00
CS137	8.81E+04
H3	1.42E+03
I129	3.08E-02
MO93	1.39E-02
NB94	1.81E+00
NI59	9.51E+00
NI63	9.43E+03
NP237	9.19E-02
PD107	1.23E-01
PU238	2.19E+02
PU239	2.87E+02
PU240	1.45E+02
PU241	1.30E+04
PU242	1.05E-01
RA226	2.52E-01
SE79	5.56E-02
SM151	5.28E+02
SN121M	2.78E-01
SN126	1.251E-01
SR90	5.729E+04
TC99	1.409E+01
U234	8.217E-01
U235	3.292E-02
U238	1.554E+00
ZR93	5.649E-01

Structure T34-0	
Nuclide	Activity (GBq)
AG108M	5.11E+00
AM241	5.66E+02
AM243	2.34E+00
BE10	1.02E-03
C14	3.84E+02
CA41	2.56E-02
CL36	3.56E+01
CM242	9.03E-01
CM243	1.05E+00
CM244	1.97E+02
CO60	5.12E+03
CS135	1.10E+00
CS137	3.22E+04
H3	4.98E+03
I129	1.18E-02
MO93	4.88E-03
NB94	7.76E-01
NI59	8.59E+00
NI63	6.13E+03
NP237	3.98E-01
PD107	4.39E-02
PU238	2.82E+02
PU239	4.59E+02
PU240	1.97E+02
PU241	1.83E+04
PU242	1.20E-01
SE79	2.05E-02
SM151	1.88E+02
SN121M	1.02E-01
SN126	4.60E-02
SR90	1.93E+04
TC99	5.06E+00
U232	4.64E-03
U234	4.96E+00
U235	2.21E-01
U236	1.23E+00

Structure T34-1	
Nuclide	Activity (GBq)
AG108M	7.14E+01
AM241	1.47E+01
AM243	5.31E-02
BE10	1.43E-02
C14	1.29E+03
CA41	3.57E-01
CL36	2.66E+01
CM242	2.59E-03
CM243	3.01E-04
CM244	1.39E+00
CO60	7.14E+04
CS135	5.88E-02
CS137	5.85E+03
H3	4.17E+03
I129	5.01E-03
MO93	7.12E-02
NB94	8.89E+00
NI59	6.18E+01
NI63	6.49E+04
NP237	1.12E-01
PD107	3.44E-03
PU238	3.67E+01
PU239	5.98E+01
PU240	2.69E+01
PU241	1.73E+03
PU242	5.19E-03
SE79	2.86E-01
SM151	1.13E+01
SN121M	1.43E+00
SN126	6.424E-01
SR90	1.563E+03
TC99	5.669E-01
U232	8.126E-03
U234	1.060E+00
U235	3.083E-02
U236	6.452E-02
U238	3.476E+00
ZR93	1.510E+00

Structure T34-2	
Nuclide	Activity (GBq)
AG108M	4.25E+01
AM241	2.27E+02
AM243	2.17E-01
BE10	8.50E-03
C14	6.93E+02
CA41	2.12E-01
CL36	3.84E+00
CM242	1.48E-05
CM244	1.40E+01
CO60	4.25E+04
CS135	5.83E+01
CS137	1.68E+06
H3	1.08E+04
I129	5.95E-01
MO93	4.25E-02
NB94	5.26E+00
NI59	3.87E+01
NI63	4.24E+04
NP237	7.28E-03
PD107	2.33E+00
PU238	1.40E+02
PU239	3.36E+02
PU240	4.29E+01
PU241	7.50E+03
PU242	1.18E-01
SE79	1.70E-01
SM151	1.00E+04
SN121M	8.50E-01
SN126	3.82E-01
SR90	6.09E+05
TC99	2.67E+02
U232	9.87E-03
U234	2.10E+01
U235	1.06E+00
U236	7.86E-02
U238	2.07E+01
ZR93	7.44E-01

Structure T35-1	
Nuclide	**Activity (GBq)**
AG108M	4.57E+01
AM241	9.43E+02
AM243	4.30E+00
BE10	9.13E-03
C14	1.01E+03
CA41	2.28E-01
CL36	1.32E-01
CM242	2.24E-05
CM243	1.69E+00
CM244	2.57E+02
CO60	4.57E+04
CS135	2.83E+00
CS137	9.24E+04
H3	1.36E+03
I129	4.05E-02
MO93	4.57E-02
NB94	7.86E+00
NI59	1.05E+02
NI63	5.75E+04
NP237	9.13E-02
PD107	1.13E-01
PU238	2.81E+02
PU239	1.11E+03
PU240	1.66E+02
PU241	1.51E+04
PU242	7.88E-01
RA226	1.65E-04
RA228	1.59E-06
SE79	1.83E-01
SM151	4.883E+02
SN121M	9.132E-01
SN126	4.109E-01
SR90	5.691E+04
TC99	1.366E+01
U232	1.136E-02
U234	1.508E+02
U235	7.094E+00
U236	1.004E-01
U238	1.503E+02
ZR93	1.038E-01

Structure T35-2	
Nuclide	**Activity (GBq)**
AG108M	9.45E+01
AM241	1.13E+03
AM243	4.24E+00
BE10	1.89E-02
C14	1.46E+03
CA41	4.73E-01
CL36	1.70E-01
CM243	2.39E+00
CM244	2.27E+02
CO60	9.45E+04
CS135	3.29E+00
CS137	1.06E+05
H3	2.25E+03
I129	4.54E-02
MO93	9.45E-02
NB94	1.22E+01
NI59	9.13E+01
NI63	8.49E+04
NP237	9.71E-02
PD107	1.31E-01
PU238	2.79E+02
PU239	1.06E+03
PU240	1.15E+02
PU241	1.60E+04
PU242	1.74E-01
SE79	3.78E-01
SM151	5.66E+02
SN121M	1.89E+00
SN126	8.51E-01
SR90	6.68E+04
TC99	1.58E+01
TH232	1.84E+00
U232	9.58E-03
U234	2.83E+02
U235	1.33E+01
U236	9.40E-02
U238	2.83E+02
ZR93	2.06E+00

Structure TB1	
Nuclide	Activity (GBq)
AG108M	1.69E+02
AM241	1.24E+00
BE10	1.00E+00
C14	1.18E+03
CA41	1.06E+00
CL36	1.01E+00
CO60	1.16E+03
CS135	1.47E+00
CS137	1.48E+03
H3	3.32E+01
I129	1.01E+00
MO93	1.01E+00
NB94	2.44E+01
NI59	1.45E+13
NI63	6.93E+02
PD107	1.02E+00
PU238	1.21E+03
PU239	2.19E+03
PU240	1.44E+02
PU241	1.31E+05
RA226	6.61E+01
SE79	1.05E+00
SM151	2.40E+06
SN121M	1.24E+00
SN126	1.11E+00
SR90	8.48E+02
TC99	3.73E+00
TH232	1.84E+02
U234	8.06E+00
U235	2.237E+00
U238	8.064E+00
ZR93	1.875E+00

Structure TB2	
Nuclide	Activity (GBq)
AG108M	7.86E-02
AM241	2.40E+00
BE10	1.57E-05
C14	9.17E+00
CA41	3.93E-04
CL36	7.86E-05
CM242	1.41E-02
CM244	3.53E-02
CO60	7.88E+01
CS135	4.72E-03
CS137	1.35E+02
H3	6.00E+05
I129	4.72E-05
MO93	7.86E-05
NB94	3.93E-02
NI59	7.86E-01
NI63	4.72E+01
PD107	1.89E-04
PU238	7.58E+02
PU239	2.19E+03
PU240	2.40E+02
PU241	1.11E+05
PU242	4.26E-02
RA226	4.17E+01
SE79	3.14E-04
SM151	8.12E-01
SN121M	1.57E-03
SN126	7.07E-04
SR90	1.79E+01
TC99	2.16E-02
TH232	1.19E+02
U234	8.94E+00

Structure TB3	
Nuclide	**Activity (GBq)**
AG108M	2.69E-02
AM241	1.01E-04
BE10	5.38E-06
C14	2.75E+00
CA41	1.35E-04
CL36	2.69E-05
CO60	6.37E+01
CS135	2.63E-03
CS137	1.51E+02
H3	1.91E+01
I129	2.63E-05
MO93	2.69E-05
NB94	1.27E-02
NI59	2.50E-01
NI63	1.54E+01
PD107	1.05E-04
PU238	5.46E+02
PU239	2.91E+03
PU240	2.83E+02
PU241	1.20E+05
RA226	3.03E+03
RA228	3.23E+03
SE79	1.08E-04
SM151	4.51E-01
SN121M	5.38E-04
SN126	2.42E-04
SR90	3.75E+01
TC99	1.20E-02
TH232	1.30E+01
U234	8.158E+00
U235	3.670E-01
U238	8.158E+00
ZR93	2.447E-03

Structure TB4	
Nuclide	**Activity (GBq)**
AG108M	1.34E-01
AM241	5.75E-04
BE10	2.69E-05
C14	1.80E+01
CA41	6.72E-04
CL36	1.34E-04
CO60	1.82E+02
CS135	9.96E-03
CS137	3.80E+02
H3	3.35E+01
I129	9.98E-05
MO93	1.34E-04
NB94	5.67E-02
NI59	1.07E+00
NI63	7.01E+01
PD107	4.01E-04
PU238	7.74E+02
PU239	2.94E+03
PU240	2.52E+02
PU241	7.08E+04
RA226	2.66E-01
RA228	6.04E+02
SE79	5.38E-04
SM151	1.71E+00
SN121M	2.69E-03
SN126	1.21E-03
SR90	2.34E+02
TC99	4.56E-02
TH232	2.27E-01
U234	1.84E+00
U235	8.27E-02
U238	1.84E+00
ZR93	9.39E-03

Structure TBC-1	
Nuclide	**Activity (GBq)**
AG108M	1.35E+01
AM241	1.43E+03
AM243	5.59E+01
BE10	2.70E-03
C14	1.16E+03
CA41	6.76E-02
CL36	5.60E+01
CM242	1.37E-01
CM244	2.61E+03
CO60	2.04E+04
CS135	8.42E-01
CS137	3.23E+04
H3	8.75E+03
I129	8.53E-03
MO93	1.32E-02
NB94	5.51E+00
NI59	1.03E+02
NI63	7.03E+03
NP237	5.12E-04
PD107	3.49E-02
PU238	1.07E+04
PU239	1.83E+04
PU240	3.97E+03
PU241	5.00E+05
PU242	1.19E+00
RA226	6.25E-02
RA228	2.16E+01
SE79	5.41E-02
SM151	1.45E+02
SN121M	2.705E-01
SN126	1.217E-01
SR90	2.795E+04
TC99	3.897E+00
U234	1.788E+01
U235	8.045E-01
U238	1.788E+01
ZR93	4.345E-01

Structure TBC-2	
Nuclide	**Activity (GBq)**
AG108M	2.90E+01
AM241	3.16E+02
AM243	6.82E-01
BE10	5.81E-03
C14	3.53E+03
CA41	1.45E-01
CL36	3.85E+02
CM242	1.47E-02
CM244	2.93E+01
CO60	2.98E+04
CS135	3.73E-01
CS137	1.87E+04
H3	5.08E+04
I129	7.46E-03
MO93	2.65E-02
NB94	4.47E+00
NI59	3.10E+01
NI63	1.00E+04
NP237	1.21E-02
PD107	1.94E-02
PU238	9.77E+02
PU239	1.15E+04
PU240	1.93E+03
PU241	1.38E+05
PU242	7.60E-01
SE79	1.16E-01
SM151	6.62E+01
SN121M	5.81E-01
SN126	2.61E-01
SR90	2.43E+03
TC99	2.08E+00
U234	1.09E+00
U235	7.91E-01
U238	1.09E+00
ZR93	1.24E+00

Structure TBH	
Nuclide	Activity (GBq)
AG108M	2.92E-03
AM241	1.48E+00
BE10	5.85E-07
C14	1.46E-01
CA41	1.46E-05
CL36	2.92E-06
CO60	2.92E+00
CS135	2.13E-02
CS137	6.09E+02
H3	3.66E+00
I129	2.13E-04
MO93	2.92E-06
NB94	1.46E-03
NI59	2.92E-02
NI63	1.75E+00
PD107	8.53E-04
PU238	2.93E+01
PU239	6.52E+01
PU240	4.90E+01
PU241	3.88E+03
PU242	2.72E-02
RA226	2.85E+02
SE79	1.17E-05
SM151	3.66E+00
SN121M	5.85E-05
SN126	2.63E-05
SR90	1.77E+02
TC99	9.75E-02
TH232	9.63E+00
U235	7.326E-01
ZR93	1.233E-02

Structure TBW-1	
Nuclide	Activity (GBq)
AG108M	3.92E+00
AM241	2.59E+03
AM243	2.67E+00
BE10	7.84E-04
C14	5.39E+02
CA41	1.96E-02
CL36	3.92E-03
CM244	3.70E+03
CO60	7.27E+04
CS135	1.60E+00
CS137	5.99E+04
H3	5.88E+04
I129	1.60E-02
MO93	3.92E-03
NB94	1.95E+00
NI59	3.90E+01
NI63	2.34E+03
NP237	8.84E-05
PD107	6.39E-02
PU238	8.96E+03
PU239	1.47E+04
PU240	1.91E+03
PU241	2.17E+05
PU242	2.50E-01
RA226	1.78E+01
RA228	1.52E+02
SE79	1.57E-02
SM151	2.74E+02
SN121M	7.84E-02
SN126	3.53E-02
SR90	1.94E+03

Structure TBW-2	
Nuclide	**Activity (GBq)**
AG108M	1.99E+00
AM241	1.75E+03
AM243	1.40E+00
BE10	3.98E-04
C14	1.91E+02
CA41	9.94E-03
CL36	1.99E-03
CM244	1.72E+03
CO60	3.65E+03
CS135	3.58E-01
CS137	1.43E+04
H3	1.28E+03
I129	3.58E-03
MO93	1.99E-03
NB94	8.25E-01
NI59	1.56E+01
NI63	1.02E+03
NP237	1.21E-04
PD107	1.44E-02
PU238	4.27E+03
PU239	7.97E+03
PU240	1.08E+03
PU241	1.48E+05
PU242	2.12E-01
RA226	9.25E+01
RA228	4.50E+01
SE79	7.95E-03
SM151	6.14E+01
SN121M	3.98E-02
SN126	1.790E-02
SR90	1.226E+03
TC99	1.638E+00
U234	1.564E+01
U235	7.032E-01
U238	1.564E+01
ZR93	2.403E-01

Structure TO3	
Nuclide	**Activity (GBq)**
AG108M	7.41E-02
AM241	3.58E-03
BE10	1.48E-05
C14	5.02E+00
CA41	3.70E-04
CL36	7.41E-05
CO60	7.41E+01
CS135	2.22E-03
CS137	6.34E+01
H3	7.28E+00
I129	2.22E-05
MO93	7.41E-05
NB94	1.05E-02
NI59	6.23E-02
NI63	1.79E+01
PD107	8.87E-05
PU238	4.30E-02
PU239	7.53E+01
PU240	8.21E+00
PU241	2.68E+03
RA226	1.85E+01
SE79	2.96E-04
SM151	3.80E-01
SN121M	1.48E-03
SN126	6.67E-04
SR90	7.25E+01
TC99	1.01E-02
TH232	1.55E+01
U234	7.57E-02
U235	3.41E-03
U238	7.57E-02
ZR93	3.71E-03

Structure **A_CSM**	
Nuclide	**Activity (GBq)**
AG108M	1.20E+02
AM241	7.49E+02
AM243	3.45E-01
BE10	2.39E-02
C14	5.42E+03
CA41	5.98E-01
CL36	1.76E+01
CM242	9.46E+00
CM244	6.80E+01
CO60	1.24E+05
CS135	3.59E+00
CS137	1.29E+05
H3	4.59E+03
I129	6.15E-02
MO93	1.20E-01
NB94	4.90E+01
NI59	9.33E+02
NI63	8.24E+04
NP237	2.14E+00
PD107	2.06E-01
PU238	3.55E+03
PU239	7.05E+03
PU240	9.27E+02
PU241	1.72E+06
PU242	2.11E+00
RA226	1.35E+02
RA228	1.42E+02
SE79	4.79E-01
SM151	6.41E+02
SN121M	2.39E+00
SN126	1.08E+00
SR90	1.48E+04
TC99	2.01E+01
TH232	7.72E+01
U232	2.00E+00
U233	4.07E+00
U234	1.05E+02
U235	4.20E+01
U238	9.93E+01
ZR93	6.14E+00

This "disposal structure", referred to as "A-CSM", is a fictitious structure containing the inventory of waste packages that were sent to the CSM for disposal but the precise location of which is currently unknown.

5.2 Distribution of the inventory of chemical toxics by disposal structure

Structure FMI-1	
Toxic element	**Mass (kg)**
Ni	67
U	6

Structure FMI-2	
Toxic element	**Mass (kg)**
B	1128
Cd	1613
Cr	7
Hg	247
Ni	181
Pb	45370
$PbSO_4$	1889
U	7479

Structure MI0	
Toxic element	**Mass (kg)**
B	1940
Cd	387
Cr	4
NI	343

Structure MI1	
Toxic element	**Mass (kg)**
B	80
Cr	4
Ni	868
Pb	183
U	26

Structure MI1	
Toxic element	**Mass (kg)**
B	80
Cr	4
Ni	868
Pb	183
U	26

Structure MI2	
Toxic element	**Mass (kg)**
Ni	119

Structure MI3	
Toxic element	**Mass (kg)**
Ni	28

Structure P1	
Toxic element	**Mass (kg)**
B	9000
Be	1
Ni	302
Pb	255600
$PbSO_4$	799700
U	1274

Structure P10	
Toxic element	**Mass (kg)**
Ni	116
Pb	189100

Structure P10bis	
Toxic element	**Mass (kg)**
B	6876
Cr	22
Ni	115
Pb	265600
$PbSO_4$	29950
U	15030

Structure P11	
Toxic element	**Mass (kg)**
B	208
Cr	3
Ni	179
Pb	254100

Structure P11bis	
Toxic element	**Mass (kg)**
B	7231
Cr	6
Ni	68
Pb	99480
$PbSO_4$	18260
U	10490

Structure P12	
Toxic element	**Mass (kg)**
B	1554
Cr	4
Ni	333
Pb	145300
$PbSO_4$	253
U	68

Structure P12bis	
Toxic element	**Mass (kg)**
B	2510
Cr	3
Ni	33
Pb	60240
$PbSO_4$	7296
U	13670

Structure P13-1	
Toxic element	**Mass (kg)**
B	1858
Cd	281
Cr	14
Ni	150
Pb	175900
U	1468

Structure P13-2	
Toxic element	**Mass (kg)**
B	1386
Cd	646
Cr	59
Ni	301
Pb	673200
U	834

Structure P13-3	
Toxic element	Mass (kg)
B	2839
Cd	1640
Cr	42
Ni	321
Pb	157400
U	1459

Structure P14	
Toxic element	Mass (kg)
B	2355
Cd	47
Cr	5
Ni	162
Pb	108900
$PbSO_4$	3840
U	1062

Structure P15	
Toxic element	Mass (kg)
B	763
Cr	1
Ni	242
Pb	54430
$PbSO_4$	3840
U	1660

Structure P16	
Toxic element	Mass (kg)
B	4404
Cr	4
Ni	168
Pb	83870
$PbSO_4$	3072
U	3960

Structure P17	
Toxic element	Mass (kg)
B	10170
Cr	39
Hg	205
Ni	482
Pb	275400
$PbSO_4$	2304
U	5542

Structure P17bis	
Toxic element	Mass (kg)
B	2118
Cr	9
Ni	61
Pb	78740
U	57

Structure P18	
Toxic element	**Mass (kg)**
B	13180
Cd	547
Cr	40
Hg	78
Ni	156
Pb	238000
$PbSO_4$	11060
U	1377

Structure P19	
Toxic element	**Mass (kg)**
B	3291
Cr	26
Ni	107
Pb	118400
U	2697

Structure P2	
Toxic element	**Mass (kg)**
Be	0
Cr	0
Ni	27
Pb	4259
$PbSO_4$	256700
U	1554

Structure P20	
Toxic element	**Mass (kg)**
B	3000
Cd	84
Cr	44
Ni	247
Pb	375200
U	472

Structure P21	
Toxic element	**Mass (kg)**
B	4706
Cd	618
Cr	24
Ni	527
Pb	323800
U	882

Structure P22	
Toxic element	**Mass (kg)**
B	3308
Cd	169
Cr	23
Ni	143
Pb	114200
U	775

Structure P23	
Toxic element	**Mass (kg)**
B	8177
Cr	102
Ni	829
Pb	520600
U	5650

Structure P24-0	
Toxic element	**Mass (kg)**
B	2741
Cr	15
Ni	146
Pb	146500
U	1106

Structure P24-1	
Toxic element	**Mass (kg)**
B	1553
Cr	4
NI	67
Pb	179000
U	449

Structure P25-0	
Toxic element	**Mass (kg)**
B	1205
Cr	6
Ni	99
Pb	84740
U	107

Structure P25-1	
Toxic element	**Mass (kg)**
B	2652
Cr	36
NI	249
Pb	272000
U	32

Structure P25-3	
Toxic element	**Mass (kg)**
B	225
Cr	1
Ni	12
Pb	33480
U	37

Structure P26	
Toxic element	**Mass (kg)**
B	3402
Cr	15
Ni	210
Pb	227200
U	1380

Structure P27	
Toxic element	**Mass (kg)**
B	2205
Cr	14
Ni	144
Pb	102000
U	1141

Structure P28-1	
Toxic element	Mass (kg)
B	4446
Cd	674
Cr	65
Ni	186
Pb	739300
U	90

Structure P28-2	
Toxic element	Mass (kg)
B	6233
Cd	337
Cr	74
Ni	249
Pb	839500
U	210

Structure P29-1	
Toxic element	Mass (kg)
B	682
Cr	9
Ni	69
Pb	117300
U	130

Structure P29-2	
Toxic element	Mass (kg)
B	1639
Cr	36
Ni	311
Pb	446300
U	293

Structure P29-3	
Toxic element	Mass (kg)
B	1069
Cr	11
Ni	81
Pb	258700
U	130

Structure P3	
Toxic element	Mass (kg)
Cr	1
Ni	55
Pb	16200
U	1212

Structure P30-1	
Toxic element	Mass (kg)
B	1192
Cr	27
Ni	142
Pb	703000
U	5023

Structure P30-2	
Toxic element	Mass (kg)
B	188
Cr	14
Ni	38
Pb	129900
U	663

Structure P31-1	
Toxic element	Mass (kg)
B	1257
Cd	197
Cr	31
Ni	245
Pb	249400
U	1324

Structure P31-2	
Toxic element	Mass (kg)
B	3479
Cd	169
Cr	31
Ni	432
Pb	467400
U	949

Structure P33-1	
Toxic element	Mass (kg)
B	3507
Cr	30
Ni	64
Pb	102300
$PbSO_4$	51
U	627

Structure P33-2	
Toxic element	Mass (kg)
B	239
Cr	0
Ni	3
Pb	98840
U	47

Structure P34-1	
Toxic element	Mass (kg)
U	16

Structure P34-2	
Toxic element	Mass (kg)
Pb	95450
U	53

Structure P4	
Toxic element	Mass (kg)
Be	0
Cr	1
Ni	171
Pb	13780
U	953

Structure P5	
Toxic element	Mass (kg)
Be	4
Cd	7
Cr	13
Ni	350
Pb	164800
$PbSO_4$	9851
U	5096

Structure P5bis	
Toxic element	Mass (kg)
Be	0
Cd	87
Cr	1
Ni	20
Pb	12740
U	407

Structure P6	
Toxic element	Mass (kg)
Cd	233
Cr	13
Ni	187
Pb	3657
$PbSO_4$	4446
U	60920

Structure P7	
Toxic element	Mass (kg)
Cd	13
Cr	1
Ni	149
Pb	78420
$PbSO_4$	3912
U	1588

Structure P8	
Toxic element	Mass (kg)
B	4022
Cr	6
Ni	72
Pb	95910
$PbSO_4$	6886
U	13040

Structure P9	
Toxic element	Mass (kg)
B	1422
Cr	8
Ni	336
Pb	265500
$PbSO_4$	11580
U	12940

Structure PTW	
Toxic element	Mass (kg)
B	38
Be	0
Cr	1
Ni	1
Pb	111600
U	2496

Structure T13-1	
Toxic element	Mass (kg)
B	2029
Cr	1
NI	105
Pb	175600
U	86

Structure T13-2	
Toxic element	Mass (kg)
B	1361
Cd	140
Cr	13
Ni	54
Pb	83930
U	6841

Structure T13-3	
Toxic element	**Mass (kg)**
B	51
Cr	17
Ni	148
Pb	20110
U	3

Structure T19	
Toxic element	**Mass (kg)**
B	9727
Cr	8
Ni	167
Pb	190700
U	2944

Structure T21	
Toxic element	**Mass (kg)**
B	14260
Cd	360
Cr	69
Hg	349
Ni	421
Pb	510200
$PbSO_4$	10090
U	453

Structure T22	
Toxic element	**Mass (kg)**
B	4788
Cr	46
Ni	143
Pb	117600
U	1409

Structure T23	
Toxic element	**Mass (kg)**
B	4138
Cd	921
Cr	23
Ni	617
Pb	118400
$PbSO_4$	13830
U	1174

Structure T24-0	
Toxic element	**Mass (kg)**
B	7071
Cd	28
Cr	90
Ni	352
Pb	306200
U	2360

Structure T24-1	
Toxic element	Mass (kg)
B	330
Cr	2
Ni	62
Pb	1619
$PbSO_4$	13480
U	610

Structure T24-2	
Toxic element	Mass (kg)
B	8250
Cr	17
Ni	211
Pb	183500
U	1044

Structure T25-1	
Toxic element	Mass (kg)
B	183
Cr	1
Ni	5
Pb	13930
U	0

Structure T25-2	
Toxic element	Mass (kg)
B	139
Cr	0
Ni	130
Pb	1129
U	71

Structure T26	
Toxic element	Mass (kg)
B	658
Cr	5
Ni	115
Pb	36300
$PbSO_4$	19360
U	619

Structure T27	
Toxic element	Mass (kg)
B	1861
Cd	1627
Cr	24
Ni	83
Pb	57300

Structure T28-1	
Toxic element	Mass (kg)
B	706
Cr	11
Ni	105
Pb	35400
$PbSO_4$	35370
U	5042

Structure T28-2	
Toxic element	Mass (kg)
B	2491
Cr	15
Ni	117
Pb	175600
$PbSO_4$	27570
U	3585

Structure T28-3	
Toxic element	Mass (kg)
B	596
Cr	7
Ni	36
Pb	35150
$PbSO_4$	6456
U	190

Structure T29-1	
Toxic element	Mass (kg)
B	2.58E+02
Cr	2.14E+00
Ni	2.48E+01
Pb	2.70E+04
U	3.72E+02

Structure T29-2	
Toxic element	Mass (kg)
B	1166
Cr	7
Ni	111
Pb	33890
$PbSO_4$	16060
U	476

Structure T29-3	
Toxic element	Mass (kg)
B	2164
Cr	23
Ni	264
Pb	243800
PbSO4	17010
U	828

Structure T30-1	
Toxic element	Mass (kg)
B	1494
Cr	7
Ni	97
Pb	77090
$PbSO_4$	29720
U	622

Structure T30-2	
Toxic element	Mass (kg)
B	216
Cr	1
Ni	12
Pb	37960
U	131

Structure T32	
Toxic element	Mass (kg)
B	426
Cd	197
Cr	12
Ni	92
Pb	126800
$PbSO_4$	41
U	189

Structure T33-0	
Toxic element	Mass (kg)
B	1206
Cr	5
Ni	62
Pb	91690
U	389

Structure T33-1	
Toxic element	**Mass (kg)**
B	325
Cd	56
Cr	12
Ni	21
Pb	158000
U	186

Structure T33-2	
Toxic element	**Mass (kg)**
B	234
Cd	253
Cr	13
Ni	20
Pb	62960
U	125

Structure T34-0	
Toxic element	**Mass (kg)**
B	121
Cd	84
Cr	17
Ni	24
Pb	69210
U	740

Structure T34-1	
Toxic element	**Mass (kg)**
B	1625
Cr	24
Ni	159
Pb	255000
U	280

Structure T34-2	
Toxic element	**Mass (kg)**
B	982
Cr	5
Ni	55
Pb	294400
U	1677

Structure T35-1	
Toxic element	**Mass (kg)**
B	1379
Be	0
Cd	281
Cr	4
Ni	168
Pb	929400
U	12180

Structure T35-2	
Toxic element	**Mass (kg)**
B	1991
Be	1
Cr	34
NI	266
Pb	915800
U	22890

Structure TB1	
Toxic element	**Mass (kg)**
Pb	3248
$PbSO_4$	544000
U	653

Structure TB2	
Toxic element	**Mass (kg)**
Be	1
$PbSO_4$	162700
U	724

Structure TB3	
Toxic element	**Mass (kg)**
Be	0
Cd	33
Cr	0
Ni	1
Pb	886
$PbSO_4$	96310
U	661

Structure TB4	
Toxic element	**Mass (kg)**
Be	0.03
Cd	940
Cr	22
Ni	17
Pb	10330
$PbSO_4$	5886
U	149

Structure TBC-1	
Toxic element	**Mass (kg)**
B	3541
Cr	64
Ni	3261
Pb	214800
$PbSO_4$	174
U	1448

Structure TBC-2	
Toxic element	**Mass (kg)**
B	3550
Cr	1
Ni	151
Pb	89700
U	98

Structure TBH	
Toxic element	**Mass (kg)**
$PbSO_4$	32640
U	9

Structure TBW-1	
Toxic element	**Mass (kg)**
Cd	1933
Cr	208
Ni	1404
Pb	59440
$PbSO_4$	1229
U	377

Structure TBW-2	
Toxic element	**Mass (kg)**
Cd	540
Cr	206
Ni	1450
Pb	48080
$PbSO_4$	364
U	1266

Structure TO3	
Toxic element	**Mass (kg)**
Pb	2067
$PbSO_4$	73880
U	6

"IDENTIFYING WHETHER THERE ARE RISKS ASSOCIATED WITH THE PRESENCE OF THE DISPOSAL FACILITY - INFORMATION YIELDED BY THE SAFETY APPROACH"

*This **"Thematic Sheet"** was prepared in 2019 by Andra, the operator of the Manche radioactive waste disposal facility (CSM), with the aim of informing future generations regarding risk situations to which people might be exposed due to the presence of this facility. Notwithstanding the various measures implemented by the operator of the CSM at the time of construction to provide immediate and ongoing protection for people and the environment against the harmful effects of the waste being disposed of at the site, the safety approach requires the identification of any situations that might result in people nevertheless being exposed to radioactive or chemical effects of said waste.*

The purpose of this thematic sheet is to present the "risk situations" liable to arise in the future (despite the multiple precautions taken by the operator since 1969).

<u>*What is the Manche disposal facility and where is it located*</u>*?* *This radioactive waste disposal facility received radioactive waste packages over a period from 1969 to 1994. It is located in the municipality of La Hague (specifically, in the delegated municipality of Digulleville) – see the map below.*

1 Overview of the Manche disposal facility (CSM)

The CSM was France's first radioactive waste disposal facility. This radioactive waste contains radionuclides, most of which are said to be "short-lived". The waste also contains toxic chemical elements, including lead, cadmium and uranium. More detailed information on the disposal inventory is available in a thematic sheet similar to this one, entitled *"Inventory of waste at the CSM and record of changes over time*".

The waste was conditioned in packages. These packages were placed in disposal structures. A suitable water management system was installed to separate rainwater from water that may come into contact with waste. Between 1991 and 1997, work was carried out to cover the disposal facility with a cap designed to perform the following two functions: limit water infiltration into the disposal facility for a period of the order of 300 years, and protect the waste packages in order to limit the risk of anyone coming into "unintentional" contact with them.

On the basis of the knowledge acquired by the operator concerning the evolution of the disposal facility and its impact on the environment, future generations should be informed that water infiltrating the disposal facility might subsequently flow through the water table and potentially impact the catchment areas of the Sainte-Hélène, Grand Bel and Roteures streams (see the map in Figure 2 below; on this map, the marked locations are subject to regular monitoring in 2019. See also the map in Figure 3, showing the catchment areas impacted by the CSM).

At the time of publication, there are plans to submit an application to create public utility easements to restrict access to the disposal site and limit water use in the surrounding areas liable to be impacted by the CSM.

The diagrams below show the design of the disposal facility and the engineered cap installed to cover the waste packages and disposal structures.

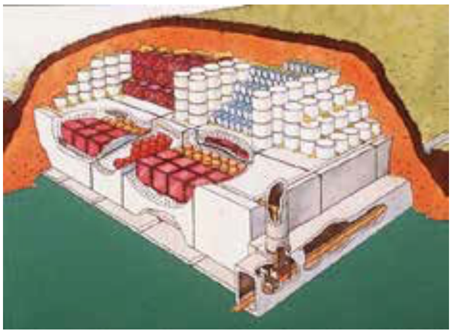
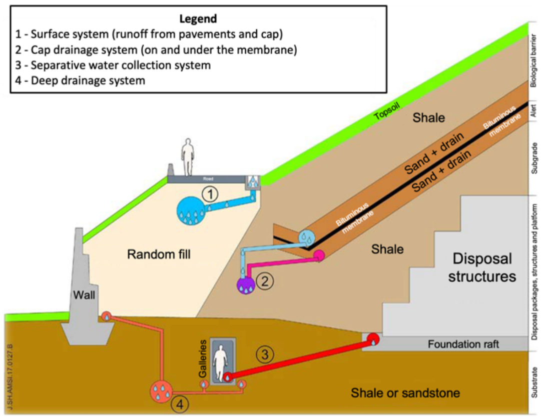


Diagram of the disposal facility showing the waste packages placed in disposal structures

Photo of a disposal structure during the operating phase (circa 1990)



Cross-sectional diagram showing the cap, disposal structures and water management system as it exists at the time of publication (2019).

Inside the cap, the <u>bituminous membrane is represented by the black line</u>. The membrane is sandwiched between two layers of draining sand. It performs the sealing function.

The layers above the geomembrane perform the protection function, guarding against aggressive hazards such as erosion and action by plants and wildlife in particular.

Figure 1 - Diagram of the disposal facility and cap - 2019

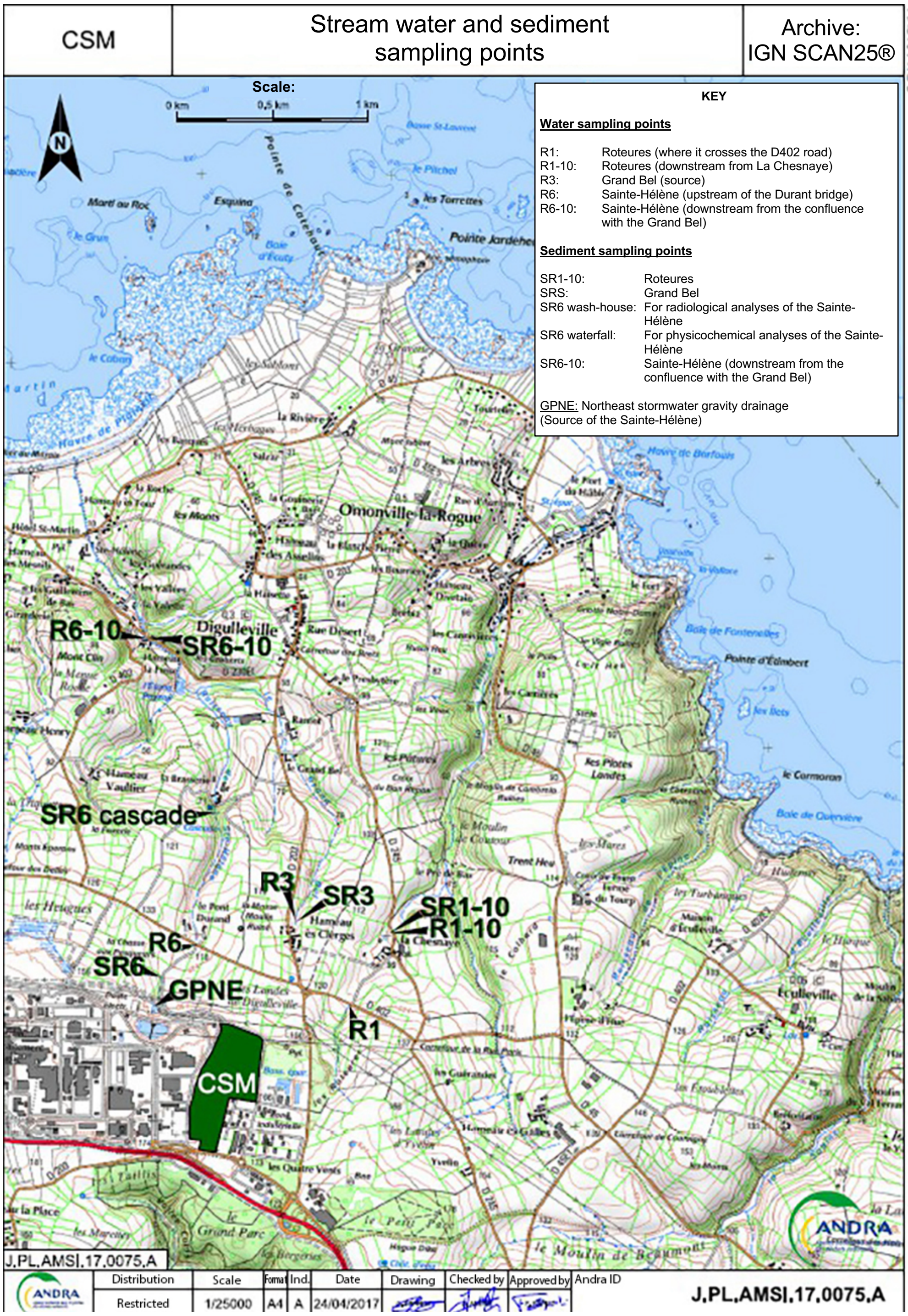


Figure 2 - Topographic map of the area around the CSM.

The geographical area subject to the influence of the disposal facility lies to the north of the CSM, and includes the Sainte-Hélène, Grand Bel and Roteures streams (downstream from the hamlet of La Chesnaye). The sampling points monitored by the operator Andra in 2019 are shown on the map (points R6 and R6-10 on the Sainte-Hélène, point R3 at the source of the Grand Bel and point R1-10 on the Roteures). Groundwater flowing between the CSM and these three streams may bear evidence of contamination originating in the disposal facility (in 2019, the operator detected the presence of tritium, a hydrogen isotope characterised by very low-energy radiation and a half-life of 12.3 years).

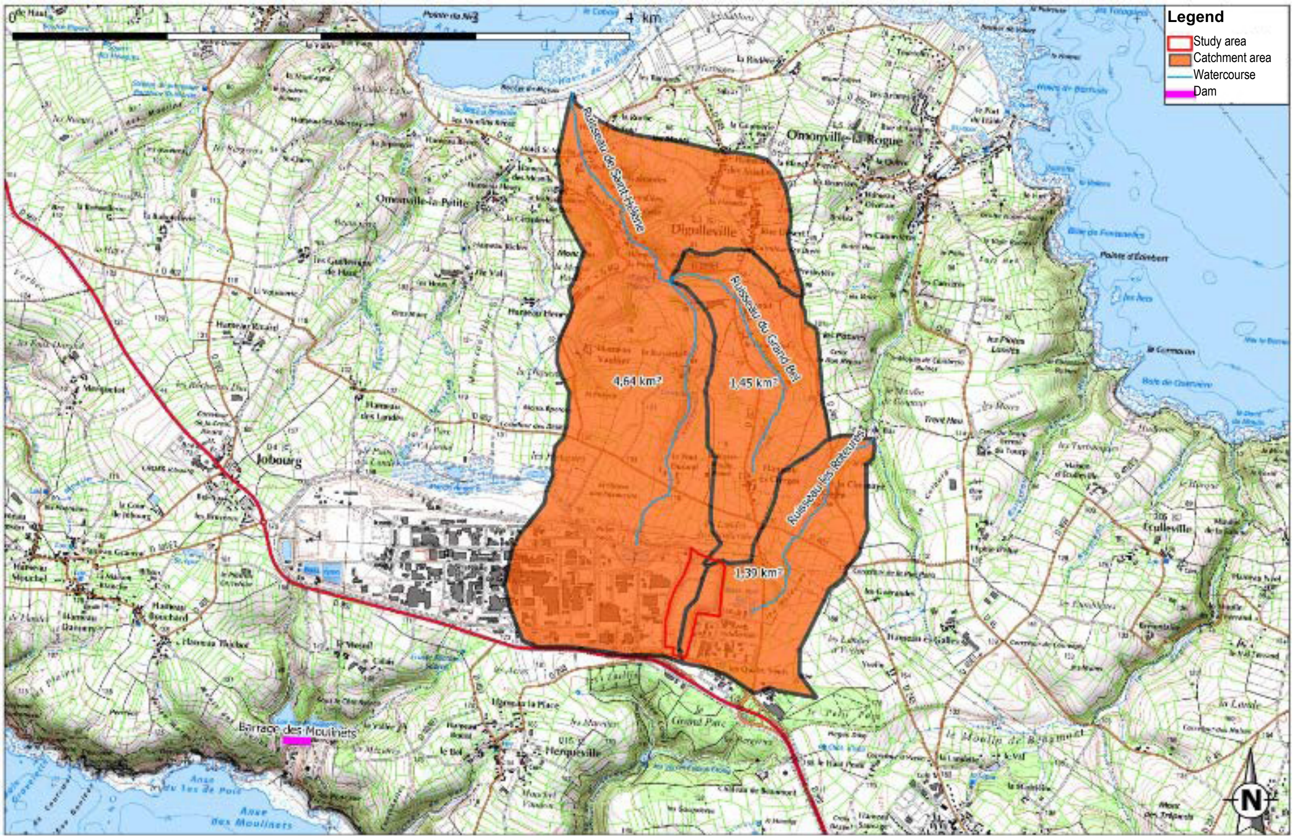


Figure 3 - Map of the river system and related catchment basins around the CSM

2 What risk situations could arise from the presence of the radioactive waste disposal facility and persist after the monitoring phase?

While the operator is present at the facility, the CSM will be monitored, maintained and if necessary, repaired. The intended duration of this monitoring period is only a few centuries, beyond which the presence of the operator on the site will no longer be necessary[1]. The disposal facility will continue to be protected by the cap, which will gradually evolve over time and may be subject to localised erosion. Easements to control access to the site and restrict land and water uses will probably have been introduced.

All these provisions have been adopted to minimise human exposure to the risks associated with the presence of this facility.

Nevertheless, in a precautionary approach, the operator was asked to identify situations that might potentially present risks for future generations, due to the presence of waste packages at the CSM. The studies conducted by the operator found that, after the monitoring phase, the situations potentially posing a risk to future generations would relate to either:

- ***A person coming into contact with one or more radioactive waste packages.*** This situation could occur only if a) the cap has been eroded or earth banks have slipped and b) a person is in the immediate vicinity of waste packages;
- ***Regular use of water (from the Sainte-Hélène, Grand Bel or Roteures streams, or groundwater)*** containing radionuclide or toxic element levels exceeding the health criteria defined at the time the situation occurred.

[1] This approach is consistent with the design guidelines applicable to this disposal facility, which were defined by the French Nuclear Safety Authority (ASN)

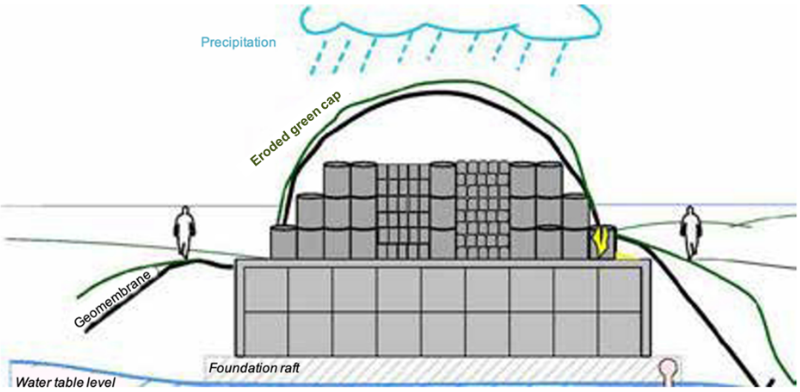
2.1 Case 1: The condition of the disposal facility has deteriorated. A rambler may approach waste packages and be exposed to radionuclides or chemical toxics

2.1.1 What situation might result in exposure to a risk?

For a rambler or other individual to come into contact with a waste package, the cap covering the disposal facility must have deteriorated and the bituminous geomembrane inside the cap (see Figure 1) must have torn[2].

A scenario involving exposure of a rambler is plausible if:

- The cap over the disposal facility has eroded in places, uncovering one or more waste packages. The packages may be either intact or damaged;
- Someone is in the vicinity of the package(s), whether simply standing nearby or handling the package(s) or the radioactive waste inside.



2.1.2 Risk assessment tips

ANALYSIS OF THE SITUATION TO ASSESS WHETHER IT MAY ENTAIL A RISK OF EXPOSING INDIVIDUALS TO IONISING RADIATION

Question: **Are any waste packages visible?**

- If the answer is "NO": the health risk should in principle be negligible

- If the answer is "YES": Answering the following questions may be useful

- In what condition is the waste package: Is it intact? Is the waste visible?
- Is suitable measuring equipment available to determine what is inside the package?
- On what date does the situation occur?
- Was the person close to the waste package(s) (i.e. within a few metres)? For how long did they remain near the package?
    - If the answer is "NO": there should in principle be no health risk
    - ***If the answer is "YES": Did they handle the package?***
        - ***If the answer is "YES": There is a risk of exposure to ionising radiation by:***
            - *External exposure* (⇔ radiation emitted by the package);
            - *Inhalation of dust* from the package
            - *Ingestion of dust* from the package (via the hands)
            - *Skin contamination* (of the hands or face) via dust

If the conclusion is "YES", there is a risk of exposure to ionising radiation; washing one's hands and then notifying health services and the municipal council is recommended.

[2] The cap consists of several superimposed layers of different natures, including a bituminous membrane, the function of which is to limit water infiltration into the disposal facility for approximately 300 years.

2.2 Case 2: Water extracted between the disposal facility and the Grand Bel, Sainte-Hélène and Roteures streams is found to contain radionuclide or toxic chemical element levels exceeding the defined health standards.

2.2.1 What situation might result in a risk?

The second considered risk situation might arise from the use of water contaminated[3] by the disposal facility. For example, water drawn from:

- The Grand Bel and Sainte-Hélène streams (and to a lesser extent the Roteures stream);
- Groundwater, pumped from a borehole between the disposal facility and the Grand Bel and Sainte-Hélène streams (and, to a lesser extent, the section of the Roteures stream near the hamlet of La Chesnaye) (see Figure 3).

This water might pose a health risk to people using it if its physicochemical and radiological characteristics exceed the values recommended by the regional health agency and the water agency at the time of reading this thematic sheet.

2.2.2 Explanation of the approach adopted for assessing the health impact of using water contaminated by the disposal facility

Step 1: If possible, before using water, measure its physicochemical and radiological properties and check them against the applicable standards (or contact the competent organisations).

Step 2: If water is extracted, specify its uses.
This makes it possible to define the pathways whereby "contaminated" water may be transferred to humans.

Illustration of the various transfer pathways considered by the operator at the time of writing

Step 3: Identify products potentially contaminated by water use (see opposite for details)

What products are potentially contaminated by water:

- Water used for drinks?
- Water drunk by livestock intended for human consumption?
- Water used in a vegetable garden?

All these "transfer pathways" can have a radiological impact on human health

For information:
Andra, in its capacity as the operator of the CSM in 2019, has taken every precaution to ensure that the use of stream water or groundwater by future generations does not pose a health problem. On the basis of the calculations performed, it can be concluded that even considering regular use of this water in a "self-sufficient" lifestyle, the health impact would be less than that of natural background radioactivity.

[3] The assessments carried out by the operator indicate that the health risk associated with water use is limited.

3 Proposed initial protective measures, if deemed necessary

The operator of the CSM advises against independent action in the area around the CSM sector: in the event that waste packages are visible, it is preferable to evacuate the area and notify the competent government agencies, enabling them to make informed decisions.

Where applicable, if protective measures are considered necessary, the operator of the Manche disposal facility recommends the following initial protective measures:

- **Check compliance with public utility easements** (*implementation still pending at the time of publication*). The purpose of such easements is to limit the possibility of someone coming into contact with waste packages (and by extension, limit the risk of unintentional human intrusion).

  Where applicable, they would also limit the ability to extract water flowing downstream from the disposal facility;

- **Limit public access to the disposal facility** (or at least in areas where the cap has deteriorated);
- **Where applicable, consolidate any deteriorated parts of the cap, to limit the risk of anyone being exposed to radiation from waste packages.**

4 Bibliography and link with the Detailed Memory File for more information

Readers seeking more information may consult the Detailed Memory File (DDM) for the CSM. Copies of the DDM are currently kept in two separate locations: at the CSM (see map above) and in the National Archives of France.

The DDM is a set of documents, classified in a filing system structured chronologically and then thematically.

Document references to search for:

[1] Decree no. 2003-30 of 10 January 2003, authorising the French National Radioactive Waste Management Agency (ANDRA) to modify the Manche radioactive waste disposal facility (basic nuclear installation no. 66), located in the municipality of Digulleville in the Manche department, in preparation for transition to the monitoring phase. This decree was considered a dismantling decree, as per Article 15 of Decree no. 2016-846 of 28 June 2016 on the modification, final shutdown and dismantling of basic nuclear installations, and subcontracting thereof.

[2] SUR RP ACSM 08.0017 – Final Safety Report – 2009 – Manche disposal facility (CSM) – ***At the time of writing, this document is the most recent safety report. It is filed in the operator's archives. At the time of writing, it has not yet been included in the Detailed Memory File.***

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