

CIGÉO PROJECT: DEFINITION AND STATUS OF ANDRA'S MONITORING STRATEGY

Sylvie Voinis¹, Soraya Thabet¹ & Frédéric Plas¹

¹ Andra, France



Table of Content

1. Framework

- What is Cigéo ?
- Key milestones of Cigéo
- Safety Options reports “Cigéo 2015”

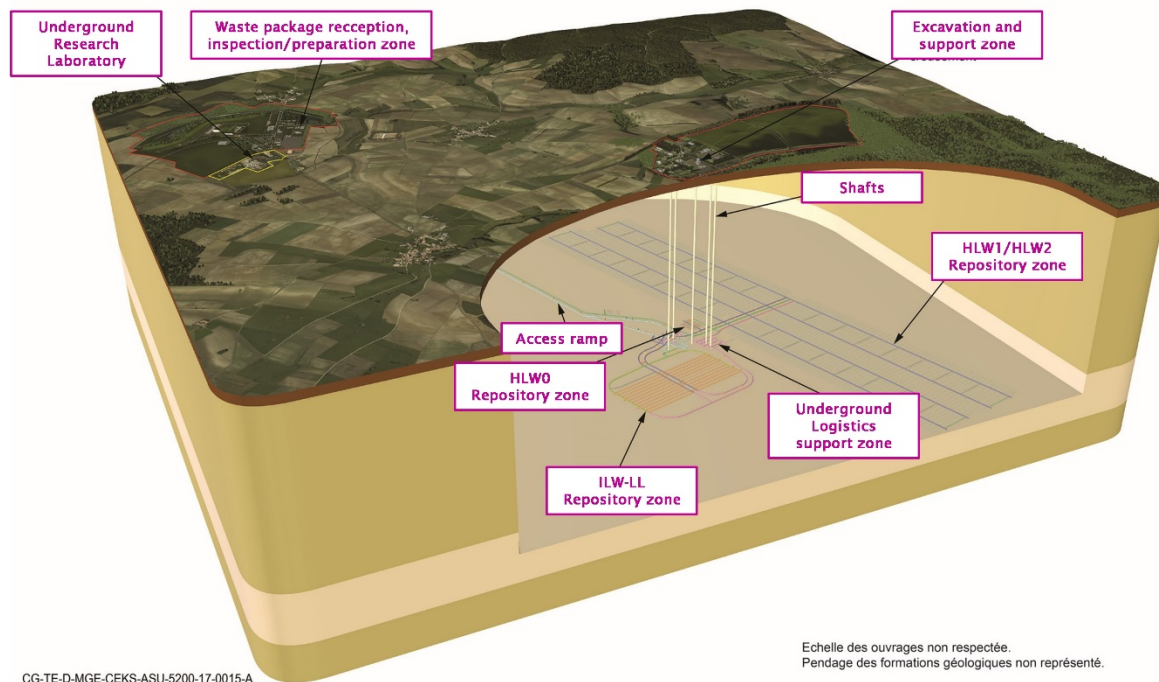
2. Main purposes of monitoring

3. A stepwise development of the monitoring program

What is Cigéo?

Différent facilities and lifetimes to be considered in the monitoring strategy

....



CG-TE-D-MGE-CEKS-ASU-5200-17-0015-A

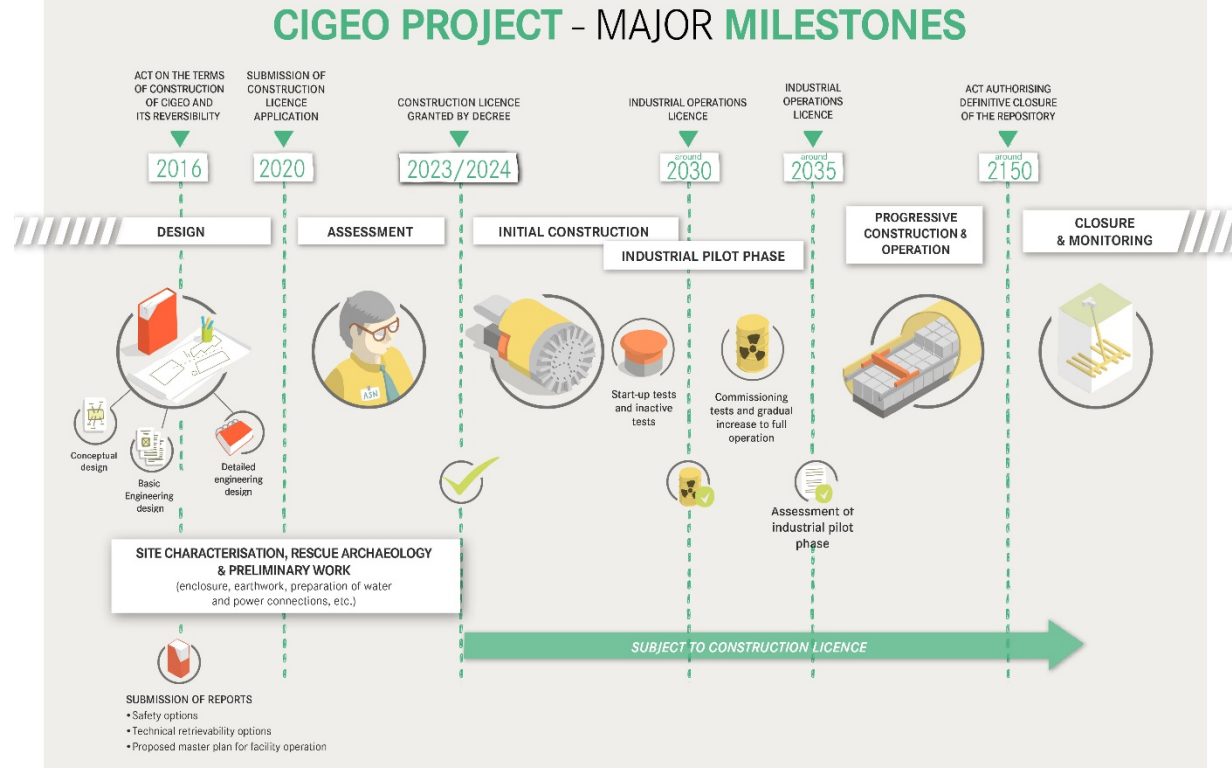
Echelle des ouvrages non respectée.
Pendage des formations géologiques non représenté.

More than 100
years of
operations

Waste package a
key element for
safety

Key milestones of Cigéo

The monitoring of Cigéo facility will start with construction



National framework

Cigéo will comply with regulatory texts related to nuclear Facility

In addition to regulatory text, according to the French ASN-2008 Geological Disposal Safety Guide, Andra has to develop a monitoring program, which intends to track the evolution of parameters characterizing the condition/state of components of the disposal facility and its geological environment, as well as the main driving processes of the further evolution of the repository.

The monitoring program has to be implemented in the phase before operation (monitoring of the baseline conditions).

During the operational phase, monitoring of the repository is required as well.

Such monitoring is described as including systematic measurements in order to control the construction, the operational safety, to provide inputs for retrievability and to assess that the repository evolves in accordance with post-closure safety requirements and that the defined monitoring parameters remain in the limits as defined in the safety case.

The monitoring program must show that the main processes are well anticipated and remain under control.

Lessons learnt from the Safety Options and its review

..... *International review on the "Safety Options File" of Cigéo...*

At the request of the NSA , the IAEA conducted an independent peer review :

- o performed against the requirements set out in the IAEA safety standards and proven international practice and experiences



Andra should further address in the development of its monitoring plan implemented during the operational phase:

- the relationship between the monitoring parameter(s) and post-closure safety;
- their feasibility of the monitoring activities planned to function over the operational period including equipment maintenance or replacement and potential detrimental impact on post-closure safety barrier performance

For detailed report see below

<https://www.iaea.org/newscenter/news/iaea-reviews-frances-project-for-high-and-intermediate-level-radioactive-waste-disposal>

Lessons learnt from the Safety Options and its review

..... *National review on the "Safety Options File" of Cigéo...*

At the request of the NSA , technical review by the TSO "IRSN"

- o Review report submitted to a standing committee
- o Monitoring aspects was reviewed

Further developp monitoring aspects into a preliminary program

1. Parameters to be monitored (post-closure, operational)
2. Technical feasibility of monitoring of key parameters related to the safety of Cigéo

For detailed report see below

<http://www.french-nuclear-safety.fr/Information/News-releases/Cigeo-radioactive-waste-disposal-facility>

Main purposes of monitoring and main aims

During construction of the repository:

- o Geological survey and some parameters related to pos-closure safety;

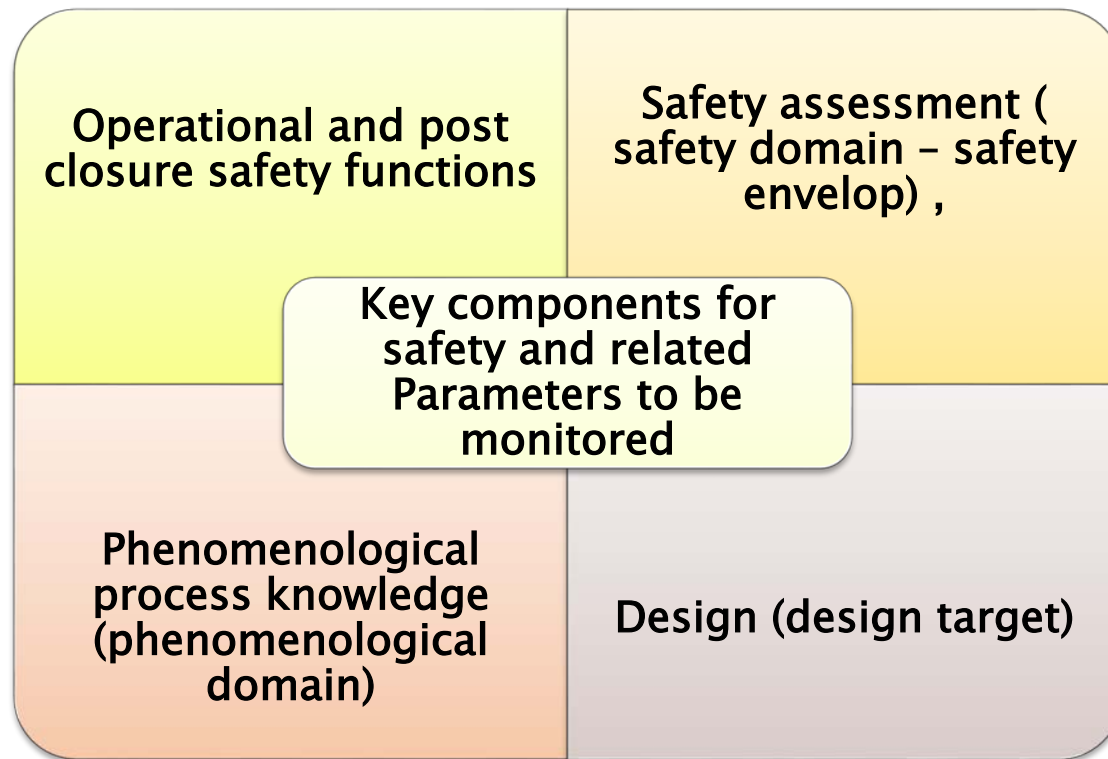
During operating:

- o Operational safety as well as parameters related to post-closure safety.

The main aims are to:

- o Check that the construction of the repository will be as defined in the licensing application;
- o Check that the installation remains in the operating area as defined in the General Operating Rules Report;
- o Identify any possible deviation in the construction and operation of the installation, which will conduct the facility to get out of this area in the absence of corrective action, before the installation does not come out of its normal operating range.

An integrated approach



Cigéo surface facilities monitoring

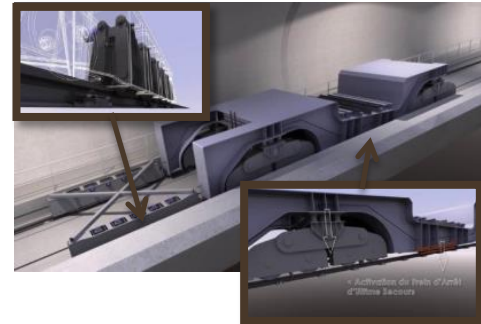
Objectives similar as for Nuclear facilities

Check that the facility stays into the operating domain



Salle de commande

Identify any drifts during the operation, before the installation leaves its normal operating domain



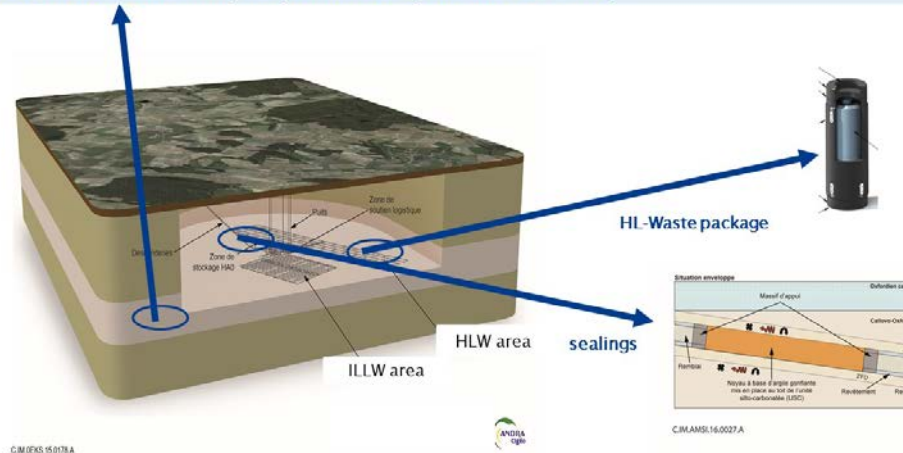
Cigéo monitoring

Cigéo post-closure safety

Cigéo is designed to isolate the waste from humans and the biosphere and to confine it within a deep geological formation to prevent dissemination of the radionuclides contained in this waste, “passively”, without the need for maintenance or monitoring.

Safety functions relies on the chosen geological medium, and specifically the host rock, and on the design of the disposal facility, and specifically its architecture and its engineered components.

The Callovo-Oxfordien, the pillar of the post-closure safety



Cigéo monitoring

Taking in to account driven processes

An appropriate level of monitoring and control is applied to Cigéo from its construction and during its operation, to ensure the protection and preservation of the passive post-closure safety features, as necessary, so that they can fulfil their safety functions once the repository is closed.

One aim is to identify the potential disturbances of the key characteristics of the Callovo-Oxfordian during construction:

- o Mechanical behavior, extension, structure and permeability of the damaged zone around the structures

Another aim is to monitor the evolution of the surrounding ambiance of the engineered barrier system components important for post-closure safety that will be installed during operation :

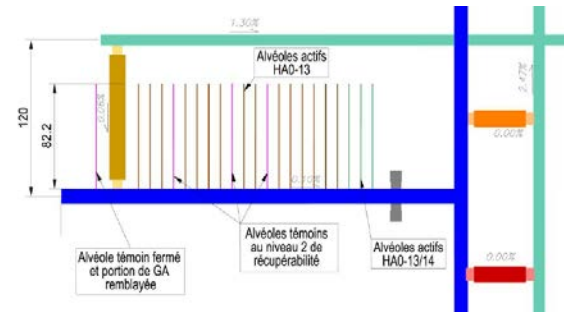
- o Hydraulic, mechanical surrounding of the HLW disposal packages.

Implementation of monitoring

Principles....

Parts of the underground installation (HA and MA-VL cells, sections of descent, wells, sections of gallery or intersections) will be monitored:

- o As representative of a set of structures:
 - case of "control cells" equipped with specific monitoring devices:
 - Give information complementary to that provided by the monitoring devices present in all the cells and valid for a set of similar cells not equipped with these devices.
- o Due to their particular positioning
 - E.g. location of a future seal



Monitoring devices

Principles

Implementation of proven technical monitoring solutions from other areas than geological disposal

- o Lessons learnt from the Meuse / Haute-Marne Underground Laboratory or other underground research laboratories abroad for several years or decades and nuclear installations, which are transposable also in the context of Cigéo.

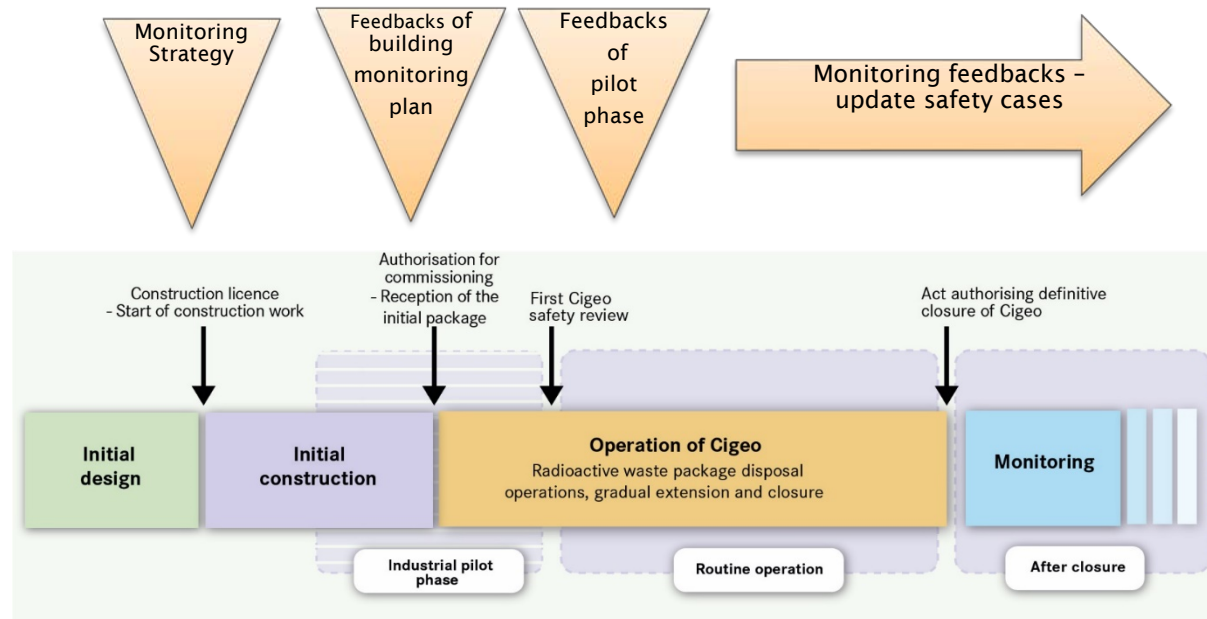
Choice of technical solutions selected for the monitoring

- o respect the passive safety requirement after closure
- o minimize the disturbance of the key components for post-closure safety
- o provide the ability to monitor installation in relation to operational risks.



Monitoring program

Successive monitoring plans



Monitoring programme

The pilot phase

Measurements of operating parameters

- o temperature, radiological atmosphere, position of packages

Monitoring of parameters related to the design and the behavior of structures with time considering the limited duration of the operational phase :

- o preservation of geometry of the disposal cells

Verification of the important characteristics of the host rock:

- o mechanical behavior, extension, structure and permeability of the damaged area around the structures

Synthesis report will help to consolidate the monitoring plan and, where appropriate, imply adaptation for the subsequent phases.

Ongoing work on monitoring program

Currently work is ongoing to map parameters to be monitored in line with the safety functions to be satisfied by the Callovo-Oxfordian and the engineered components.

The work was initiated during the establishment of the safety options and the development of the design.

This work needs technical views from design, science and safety fields, such as within Modern2020.

The monitoring programme will relate in particular to the key parameters of the underground architecture's design that will be defined at the forthcoming stage corresponding to the detailed engineering design phase of the project.

Some portions of the underground facility (HLW and ILLW-LL disposal cells, ramp and shaft sections, gallery sections or intersections) selected for their representativeness of a set of structures or for their specific position (e.g. at the location of a future seal) will be the subject of specific monitoring measures.

Ongoing work on monitoring program

Illustration



Example of Post-closure safety functions	Underground facility component examined	Estimated monitoring requirements over time
Restrict the release of radionuclides and toxic elements and immobilise them in the repository	ILLW disposal cell	Environmental conditions within the disposal cell: temperature, relative humidity, and the presence of liquid water Deformations, movements, Disposal cell deformations
Delay and mitigate the migration of radioactive substances and toxic elements	Underground facility Callovo-Oxfordian formation	Characteristics of the near-field argillites, in particular the damaged argillites (permeability, porosity, fracture, spatial extension, deformation, desaturation) Hydraulic head fields in the calcareous Oxfordian rock (porous horizons)
Protect the favourable properties of the argillites	Drifts ILLW disposal cells HLW disposal cells	Characteristics of the near-field argillites, in particular the damaged argillites (permeability, porosity, fracture, spatial extension, deformation, oxidation, temperatures)
	Geological medium	Hydraulic head fields in the calcareous Oxfordian rock (upper surrounding formation of Callovo-Oxfordian) around the surface-bottom connection structures and at the repository Pore water pressure fields in the Callovo-Oxfordian formation near the surface-bottom connection structures and the underground facility structures Temperature fields in the Callovo-Oxfordian formation near the HLW section structures



....THANK FOR YOUR ATTENTION....