

The Advisory Committee for Waste issues its recommendations on the safety of Cigéo in the operational phase

- The second stage of the technical review of the licence application for Cigéo (French DGR project) ended with the meeting of the Advisory Committee for Waste (GPD) on 10 and 11 December. This second stage focused on the safety of Cigéo in the operational phase. The discussions of the GPD were based on the expert review carried out by the IRSN.
- The GPD considered that Andra's demonstration of the operational safety of the surface facilities and underground infrastructure was generally satisfactory at this stage of the project, but that further work is required, in particular on the management of accidental situations and the prevention of hazards associated with fire and explosion.
- In the opinion that it will submit to Parliament at the end of the technical review, the ASNR will present the elements that it considers necessary for the possible issue of the construction licence (decree), as well as the prospects for additional requirements or possible hold points, in particular on the basis of the recommendations of the GPD, to define the regulatory framework for the facility in the subsequent phases of its development.
- ASNR's technical review of the application file will continue with the review of the third and final thematic section, which deals with the long-term safety of the repository after closure. This assessment will lead to a third meeting of the GPD, scheduled for mid-2025.

On 16 January 2023, Andra submitted a licence application for a deep geological repository for radioactive waste, known as Cigéo, to the French Ministry for Energy Transition. In March 2023, the ASNR was tasked by the Ministry for Energy Transition to lead the technical review of this application.

The ASNR wanted the review of the application to be divided into three review phases: (1) the baseline data used to assess the safety of Cigéo, (2) the safety during the operating phase of the surface and underground facilities, and (3) the safety after closure. The first phase of the review concluded with a meeting of the Advisory Committee for Waste¹ (GPD) on 24 and 25 April.

As with the referral of the first phase by the GPD and the referral of the entire application file by the IRSN, the referral of the second phase by the GPD was the subject of a stakeholder consultation (see below). In addition, during the first two stages, a technical dialogue was organised by the IRSN in parallel with the evaluation of the application file and will continue during the third phase (see below).

¹ With the support of members of the Advisory Committees for laboratories and plants (GPU) and for the radiological protection of workers, the public, patients, and the environment (GPRP).

Following discussions with Andra during the second review phase, the chronology of the project would now be scheduled as follows:

- an initial construction phase starting with earthworks around 2029, with excavation starting around 2035; the first ILW-LL cells would be constructed by early 2040 and the first HLW cells by 2045;
- commissioning, limited to the industrial pilot phase (PhiPil), by 2050. At this stage, Andra expects the PhiPil to last 25 to 30 years;
- a decommissioning and closure phase by 2150.

These timeframes were taken into account at the second meeting of the GPD.

The GPD met on 10 and 11 December 2024 on the basis of the expert report produced by the IRSN (see below).

At the end of this second review meeting, **the Advisory Committee considered that Andra's demonstration of the safe operation of the surface facilities and underground infrastructure was generally satisfactory at this stage of the project.** The ASNR notes that, without calling into question Cigéo's design at this stage of the review, the Advisory Committee has indicated that it wishes to examine, before the start of excavation, the additions that will be made to the demonstration of operational safety for the disposal of bituminous waste, the closure of the ILW-LL cells and the operation of the HLW-LL cells.

The recommendations and positions of the GPD will form the basis of the opinion that the ASNR will issue on this application in accordance with the provisions of Article L. 542-10-1 of the Environment Code, at the end of the entire technical review. In addition, these recommendations and positions, as well as certain commitments made by Andra during the review, may be the subject of requirements drawn up by the ASNR after the licence application is issued, with deadlines corresponding to regulatory milestones or stages of the project: updating of the preliminary safety report, commencement of construction and excavation, commissioning of the facility, etc. **Consequently, the opinion issued by the ASNR at the end of the technical review of the application file will contain, where appropriate, the elements deemed necessary for the issue of the decree, but also the prospects for the prescriptions or hold points envisaged to define the regulatory framework for the facility in the subsequent phases of its development, starting with its construction.**

More specifically, at the end of its second meeting, the Advisory Committee reached the following conclusions:

1. Operational safety approach

The fundamental safety objective adopted by Andra is to protect human health and the environment from the hazards associated with the release of radioactive or toxic chemical substances during all phases of the life of the facility and in the long term.

The Advisory Committee considered that the approach to operational safety, based on the principle of defence in depth, presented by Andra at the time of the licence application was satisfactory in a number of aspects but needed to be supplemented.

Defence in depth

Defence in depth is a structured hazard management approach based on the implementation of multiple independent levels of protection designed to prevent incidents and accidents and to mitigate their consequences. The aim of this approach is to ensure that even if one level of protection fails, the other levels remain operational to ensure the safety of the facility and the protection of workers, the public and the environment.

In particular, the Advisory Committee stressed the importance, in terms of defence in depth, of carrying out **additional studies on postulated accident situations** leading to contamination in the facility's galleries, in order to strengthen the accident and post-accident management measures that could be implemented during operation or even during construction. Where appropriate, these studies will be included into the facility's safety report, at the latest when it is updated prior to excavation.

The aim of the **monitoring strategy** developed by Andra is to ensure that the facility remains within its normal operating range during operation and to verify that disturbances related to construction and operation do not affect safety functions after closure. The Advisory Committee considers that the facility monitoring strategy, based in particular on the use of test cells, is appropriate. However, it stressed the need to specify the provisions relating to this monitoring and to justify the representativeness of the monitoring of these test cells, with a view to the implementation of the MA-LV cell demonstrator.

The Advisory Committee also considered that the **acceptance specifications for primary packages²** were consistent with the operational safety assessment. However, it recommended that the appropriateness of the number of locations in the facility dedicated to the management of packages not meeting these specifications should be justified.

Concerning the adaptability of Cigéo to the **disposal of waste from the reserve inventory**, which includes spent fuel and low-level long-lived waste, the Advisory Committee stressed that future studies should take into account the impact of a temporal or spatial extension of the facility on its operational safety (ventilation management, fire-fighting resources, durability of underground structures, etc.).

Finally, the Advisory Committee noted that the organisation implemented by Andra for the **transition from the design phase to the construction phase** still needed to be consolidated, in particular in order to control the project hazards of the Cigéo programme. As the control of the Cigéo commissioning deadline is a nuclear safety issue with regard to the waste management strategies of French licensees, the ASN carried out an initial inspection of Cigéo project management on 10 October 2023.

2. Assessment of operational safety

The Advisory Committee for Waste noted that significant progress had been made since the safety options file on the management of operational hazards, but it nevertheless identified a number of issues requiring significant additional information, in particular on the management of fire hazard, for which the Advisory Committee recommended that the provisions presented by

² Primary packages are packs that are packaged by their producer and then shipped to Cigéo. They can either be disposed directly or placed in a disposal waste package before being transferred to Cigéo.

Andra be consolidated. This concerns, in particular, the fire sectorisation defined to limit the consequences of a fire in the underground installation and the provisions relating to the response in the event of a fire to ensure a rapid and effective response. The ASNR considers that these additions should have been made before the start of excavation work, in particular those relating to the design of underground installations.

The Advisory Committee also expressed the need for more detailed information on the methods for managing the hazard of explosion in the disposal cells of the facility. Studies on the evolution of the internal atmosphere in the ILW-LL cells and on the feasibility of inerting devices in the HLW-LL cells will have to be carried out in more detail in order to prevent the formation of an explosive atmosphere. The Advisory Committee has indicated that it would like to examine these issues before excavation work begins.

Explosive atmosphere

An explosive atmosphere (ATEX) is formed when a mixture of flammable gas and oxygen reaches a concentration which, in the presence of an ignition source (heat, spark, etc.), may cause an explosion. At Cigéo, this hazard is mainly associated with the production of dihydrogen; the explosive threshold for dihydrogen is reached at a concentration of 4%.

In the case of long-lived intermediate-level waste, dihydrogen is mainly produced by the radiolysis of organic materials contained in the waste (resins, water, etc.), i.e. the decomposition of molecules under the effect of radiation. As ILW-LL cells move from the operational phase to the closure phase, stopping air renewal in the cells can lead to an accumulation of dihydrogen, increasing the ATEX hazard.

In the case of high-level waste packages, hydrogen is mainly generated by anoxic corrosion of metallic materials, such as the steel lining of the cells and the waste containers. This reaction occurs when these metals are exposed to the moisture present in the surrounding rock. The continuous production of gas in these cells poses a double challenge: controlling the explosion hazard in a cell and avoiding pressure increases that could weaken the host rock or the seals.

With regard to the disposal of bitumen waste, the Advisory Committee notes that the conservative nature of the situations postulating a runaway of exothermic reactions in the packages has not been demonstrated, and considers that the detection and intervention strategies in the event of a runaway reaction are not sufficiently justified, so that at this stage, the demonstration of the safety of the disposal of bitumen waste in its current state has not been completed. In the opinion of the ASNR, this demonstration will be necessary in order to obtain the permit to start up the industrial pilot phase; this point will be emphasised in the opinion that the ASNR will issue at the end of the technical examination of the permit application in accordance with Article L. 542-10-1 of the Environment Code.

Finally, the Advisory Committee noted the progress made on the retrievability of the packages, stressing that this capability was essential to ensure the reversibility of the project and to meet post-accident requirements.

3. Assessment of the impact on health and the environment during operation

The radiological impact of Cigéo during normal operation was considered to be very low, confirming the robustness of the measures planned to protect human health and the environment.

However, the Advisory Committee considered that a quantitative assessment of liquid discharges of toxic chemical substances should be carried out on the basis of an estimate of the concentrations released into the environment.

4. Industrial pilot phase (PhiPil)

Following the first GPD review meeting, Andra provided additional information on the industrial pilot phase, outlining the process and initial objectives and success criteria for this phase.

The Advisory Committee considered that this is still a preliminary definition of the objectives and criteria assigned to PhiPil. It stressed the need to establish a work programme for the different phases of PhiPil and considered that the definition of the number of waste packages to be disposed of and the pace of disposal operations should be based on the development of an active testing programme, i.e. tests on radioactive waste packages.

Feedback from the construction and operation of the first disposal cells will be necessary before the construction of subsequent cells can start. However, the Committee reiterated the need to ensure continuity of operations between the pilot phase and full commissioning of the facility to avoid the hazards associated with stopping and restarting an industrial facility.

Conclusions of the IRSN assessment

Risk management in operation

IRSN considers that the demonstration of risk management during the Cigéo operational phase has reached the level of maturity required at the licence application file stage for most of its components, in particular with regard to internal risks of nuclear origin (risks of criticality, radioactivity dissemination, exposure of workers to ionising radiation, etc.), risks of external aggression linked to flooding, meteorological events, the industrial environment and aircraft crashes, as well as risks of internal aggression associated with fire, internal flooding, handling of waste packages, loss of auxiliaries and co-activity. The waste acceptance specifications and the controls foreseen when packages are received at the facility are generally satisfactory. The design principles and dimensioning approach adopted by Andra for the civil engineering of the surface and underground facilities also meet the level expected at the construction licence application stage. All of these points will need to be consolidated during the next stages of the project, particularly with regard to fire risk management. Similarly, the monitoring provisions for the first structures still need to be specified before they are built. On this basis, and given the overall very low level of estimated radiological consequences, IRSN considers that the design, construction and operating provisions adopted at this stage for the reference configuration are on the whole appropriate for demonstrating the operational safety of the Cigéo surface facilities, underground infrastructure and ILW-LL disposal zone. In addition, the organisational changes initiated by Andra to transition from the design phase to the industrial phase of construction and operation are, in IRSN's view, likely to strengthen the anticipation of risk management.

The case of the HLW and ILW-LL cells

However, safety has not yet been demonstrated for the HLW cells, nor for the ILW-VLL cells when they are closed, given the uncertainties concerning the feasibility and adequacy of the provisions for managing their internal atmosphere, particularly with regard to explosion-related risks. The information presented does also not make it possible to conclude on the accessibility of this demonstration in the specific case of disposal of bituminous waste packages in their current state. Changes in operating methods or the design of disposal cells may therefore be necessary.

Consequently, IRSN considers that it is now important to complete and consolidate the assessment of the safety of Cigéo in the operational phase, by taking full advantage of the industrial pilot phase, based in particular on disposal test cells constructed *in situ* in the underground facility, under environmental and industrial operating conditions that take account of the changes in scale compared with surface tests or those carried out in the underground laboratory. In this respect, a duration for the industrial pilot phase of around thirty years from the issue of the Licensing Decree, as currently planned by Andra, seems reasonable to gather the necessary complements and confirm the facility's ability to operate safely.

Cigéo's flexibility and adaptability

In addition, IRSN emphasizes that the flexibility of the facility, which is a fundamental issue in its deployment in order to preserve the capacity for safe management of the HL and IL-LL waste from the reference inventory, must be supported by concrete organisational and material provisions. Finally, based on the preliminary operational safety analysis presented by Andra as part of the studies on the adaptability of Cigéo to the reserve inventory waste, IRSN does not identify any redhibitory issue relating to the safe disposal of spent fuel and LL-LL waste included in this reserve inventory waste.

This technical review will be supplemented by that of the post-closure safety demonstration as part of the GP3 review.

Civil society involvement in the Cigéo review process

In parallel with the review of Andra's licence application, IRSN has established a technical dialogue with the National Association of Local Information Committees and Commissions (Anccli) and the Local Information and Follow-up Committee for the Bure laboratory (Clis de Bure).

This dialogue is a continuation of the initiatives of openness to civil society on HL and IL-LL waste carried out since 2012. Held in the form of plenary meetings and thematic workshops, it aims to make the experts' assessments more robust by taking into account civil society's concerns and questions. It also enables civil society to form its own opinion on nuclear safety and radiation protection issues and thus to participate in the process leading to public decision-making.

The main topics of interest to participants in terms of GP2 expertise are waste package acceptance criteria, their control and the fate of non-compliant packages, explosion and fire risks, in particular for bituminous waste, climate change, civil engineering behaviour, organisational and human factors, health and environmental impacts, package retrievability and the pilot phase. These issues are identified by a pictogram throughout the IRSN report and are referred to in an appendix dedicated to the presentation of this technical dialogue.

The ASNR will continue this initiative in 2025 in parallel with the GP3 technical review.

Consultation as part of the review process

In order to meet the expectations of society in terms of participation in the Cigéo project, and in line with the actions planned in this respect in the 5th PNGMDR (French National Radioactive Material and Waste Management Plan), the ASN has implemented an unprecedented system of consultation around the technical review process. Various stakeholders (around twenty

organisations, including local information commissions, the ANCCLI and environmental protection associations) were consulted as part of the preparation of IRSN's review on the application for authorisation to create Cigéo, with the aim of identifying their expectations and concerns, in relation to nuclear safety and radiation protection, so that these could be taken into account when framing the review of the application file. As a result of this exercise, the IRSN's draft referral was modified to include, for example, aspects related to the consideration of climate change. In order to ensure continuity of public participation throughout the technical review process, consultation initiatives are also undertaken when the referrals to the Advisory Committee for Waste on each of the three topics mentioned above are prepared, and regular information is provided to the public, in particular after each meeting of these expert groups. This information, structured according to the referrals, will provide answers to the expectations and questions included in the referrals.

The ASNR will organise a consultation meeting to prepare the referral to the Advisory Committee for Waste for its third meeting, scheduled for mid-2025.

To find out more, click here:

- Read the opinion of the Advisory Committee
- Consult the IRSN report and opinion