

Mr P. BOIS, Deputy Director General of  
ASNR

Fontenay-aux-Roses, 6 June 2025

## Expert Opinion No. 2025-00056

**Re: Cigéo project construction licence application - “GP3” - Post-closure safety assessment**

**Reference:** Letter ASN/CODEP-DRC-2023-030596 dated 7 June 2023. Examination of the Cigéo project construction licence application file - Referral ref. SAISI-DRC-2023-0093.

On 1 January 2025, the French Nuclear Safety Authority (ASN) and the Institute for Radiation Protection and Nuclear Safety (IRSN) merged to become the Authority for Nuclear Safety and Radiation Protection (ASNR). This opinion from ASNR's Division of Environment (PSE-ENV) is in response to the letter referred to above. In the remainder of this opinion, the acronyms ASN and IRSN are retained when referring to documents or positions issued by these bodies prior to their merger.

In its letter in reference, ASN requested the opinion of IRSN regarding the construction licence application file (DDAC) for the Cigéo project of deep geological disposal of high-level (HLW) and intermediate-level long-lived (ILW-LL) waste, as submitted by the French National Agency for Radioactive Waste Management (Andra). The ASN requested an expert assessment of this DDAC, structured around three thematic groups:

- the basic data used for the Cigéo safety assessment (“GP1” review, subject of IRSN Opinion No. 2024-00051 of 12 April 2024);
- the safety assessment related to the operational phase (“GP2” review, subject of IRSN Opinion No. 2024-00167 of 29 November 2024);
- the safety assessment related to the post-closure phase (“GP3” review).

ASN also identified a number of cross-cutting themes to be incorporated into the review of these three thematic groups. These include the elements used to define the pilot industrial phase, the preliminary specifications for waste package acceptance and the reversibility (including waste package retrievability and disposal adaptability), as well as the consequences of climate change.

This opinion covers the GP3 review. For the purpose of the latter, ASN asked IRSN to give its opinion on the relevance of the design bases used to develop the baseline configuration for the disposal facility, as well as the construction and operating provisions adopted, by examining:

- the post-closure safety approach with regard to defining scenarios that take into account normal and altered long-term evolutions to the disposal system;
- the assessment of the performance of the disposal system in relation to internal and external risks;
- the estimated radiological and chemical consequences associated with each scenario.

The memory management provisions during the operational phase and the adaptability studies, which are also mentioned in the ASN referral, are included in this expert assessment. This expert assessment also includes the information transmitted by Andra in response to its commitments 2024-E12 and 2024-E41 made in the wake of GP1 and GP2 reviews, which cover the corrosion of metal components in HLW cells and seismic hazard used to design the facility in the operational phase.

This review was the subject of a technical dialogue organised by the National Association of Local Information Committees and Commissions (*Association nationale des comités et commissions locales d'information - ANCCLI*), the Local Committee for Information and Follow-up of the Bure Laboratory (*Comité local d'information et de suivi du laboratoire de Bure - CLIS de Bure*), IRSN and then ASNR with the twin aims of taking the concerns of civil society into consideration in order to make the PSE-ENV review more robust, and of allowing civil society to form its own opinion and therefore to participate in the process leading up to the public decision.

PSE-ENV's evaluation of the submitted file and the information provided by Andra during the expert assessment has resulted in the main points addressed below. The recommendations made by PSE-ENV have all been taken up by Andra in the form of commitments to ASNR, which are listed in the appendix to this opinion. Most of the associated deadlines relate to later stages of the project, conditional on the promulgation of the licensing decree authorizing its construction (start of excavation of the underground structures), or to assessment milestones (updating of the DDAC in advance of the public inquiry, revision of the preliminary version of the safety analysis report). This GP3 expert assessment by PSE-ENV will be presented to the members of the Advisory Committee of Experts for Waste (GPD) at their meeting on 25 and 26 June 2025, which will be attended by members of the Advisory Expert Committee for Laboratories and Plants (GPU) and for Radiation Protection for workers, the general public, patients and the environment (GPRP).

## 1. GP1 AND GP2 FOLLOW-UP: CORROSION AND SEISMIC HAZARD DURING OPERATION

The GP1 review highlighted significant corrosion rates on the liners and disposal containers in an HLW cell in the presence of the initial formulation of the cementitious material intended for use in the annular space between the rock and the lining, which compromises performance of their functions. During the GP3 review, Andra thus provided a summary presentation of the research programme it is conducting on the corrosion of these metal components, supplemented by the main results obtained up to the end of August 2024. Based on this information, PSE-ENV notes the limited progress of the research programme at this stage and notes that the few additional results presented in the wake of GP1 have enabled Andra to specify the formulation of the cementitious filler material it currently favours, but are not sufficient to lift the reservations raised at the end of the GP1 review. Therefore, as was the case at the end of the GP1 review, PSE-ENV considers that, at this stage, the data available to justify the design of the metal components of the HLW cell are still subject to significant uncertainties, which constitutes a point requiring particular attention to rule on the relevance of the HLW cell concept used in the DDAC.

Following the GP2 review, Andra agreed to develop a new seismic hazard level for the design of the facility in the operational phase that takes better account of the uncertainties associated with the definition of seismic events. PSE-ENV considers that the revised seismic hazard level presented by Andra during the GP3 review, which follows the recommendations made in the GP2 review, is now satisfactory.

## 2. POST-CLOSURE SAFETY ASSESSMENT APPROACH

The aim of assessing the post-closure safety of Cigéo is to ensure its long-term passive safety, i.e., that there is no need for any intervention to protect people and the environment from the risks associated with the release of radioactive and toxic chemicals. This assessment must also demonstrate the robustness of the disposal system, which comprises the Callovo-Oxfordian (COx) host rock, the engineered disposal components and the waste packages, in respect of the uncertainties relating in particular to the long-term evolution of this system and the geological environment.

The general approach adopted by Andra thus comprises two parts: the analysis of the internal and external risks and the uncertainties associated with the future evolution of the components of the disposal facility, and the quantitative assessment of the overall containment capacity of the disposal facility, taking into account these risks and uncertainties via disposal evolution scenarios. This second part also includes, *in fine*, verification of compliance with the protection objectives based on the estimated health and environmental impacts for these scenarios. Andra classifies the disposal evolution scenarios selected according to the probability of their occurrence:

- the Normal Evolution Scenario (NES) or “normal evolution range”, which corresponds to the foreseeable evolution of the facility and the geological environment, with all the safety functions considered satisfied;
- Altered Evolution Scenarios (AES), associated with uncertain but plausible events, which are intended to assess the consequences of component malfunctions that could lead to degraded performance or partial loss of a safety function;
- “What-if?”-type scenarios, which postulate highly implausible events in order to test the robustness of the disposal system.

In addition to these three scenario categories, there is a specific category of inadvertent human intrusion scenarios (IHIS) that does not take into account the likelihood of their occurrence and which is included in the safety assessment in order to test the robustness of the disposal system to this type of event. PSE-ENV considers that Andra's general approach to assessing the post-closure safety of Cigéo, which complies with the applicable standards and guidelines and is in line with the approach presented at the stage of the safety options dossier (DOS), is satisfactory.

With regard to implementation of this approach, PSE-ENV has no comment to make regarding the safety functions of the post-closure disposal system selected by Andra and the corresponding list of components important for protection (CIP). PSE-ENV considers that Andra's choice and definition of biospheres to assess the post-closure radiological impact and the impact of released toxic chemicals are relevant. In particular, PSE-ENV considers that the warm and cold biospheres selected, which take account of climate change studies, allow for the uncertainties inherent in very long-term climate predictions to be included. In addition, PSE-ENV considers that the radiological health protection objectives are broadly consistent, in principle, with the applicable national and international guidelines, as are the environmental protection objectives relating to radioactive substances and toxic chemicals. However, the assessment of the health impact of releases of toxic chemicals from the disposal facility requires additional methodological elements relating, in particular, to the estimation of substance concentrations in the environmental matrices and the quantification of population exposure (commitment 2025-E5), but these shortcomings are not likely to call into question the very low health impacts of the toxic chemicals assessed by Andra.

Finally, the preparation of the memory maintenance systems is satisfactory at the current stage of development of the Cigéo project, particularly in terms of the descriptive disposal files planned at different levels of detail. These systems also include registration of the site in the town and country planning documents, exchanges with civil society and other memory tools such as site markers in line with international initiatives. According to PSE-ENV, the method for selecting which data are to be archived should be consolidated before the start of the earthworks, and the methods for storing this data should be defined at least up until Cigéo enters the monitoring phase.

### 3. ANALYSIS OF RISKS AND UNCERTAINTIES

In order to protect the favourable properties of the COx from a critical excursion linked to the presence of fissile material (FM) in the waste, Andra intends to manage the long-term criticality risk in the disposal facility following its closure. Andra's assessment of the subcriticality of the disposal facility following its closure is based on studies to determine the impact of foreseeable evolutions to the packages and cells on the critical mass of FM. In this regard, PSE-ENV considers it necessary for Andra to consolidate its demonstration of the absence of a post-closure criticality risk by justifying the conservative nature of the disposal evolution models considered in its criticality safety analyses with regard, in particular, to the expected degradation of the cementitious materials (commitments 2025-E1 and E2). PSE-ENV notes that the critical masses determined in the different post-closure disposal evolution models are, with very few exceptions<sup>1</sup>, greater than the maximum permissible FM masses specified in the acceptance criteria for primary packages in the disposal facility. These results suggest that the criticality risk after closure of the disposal facility is managed, subject to the afore-mentioned consolidation of the models.

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<sup>1</sup> One 870 L FI package and one type of PIVER package, whose FM content exceeds the maximum permissible masses for these package types, were identified during the review. Their potential acceptance in Cigéo by way of derogation shall be subject to an additional demonstration of criticality risk management.

Furthermore, PSE-ENV has no comment to make on the demonstration of the management of the effects on the containment capacity of the disposal facility of the swelling under water of bituminous waste; of the gases during the hydraulic-gas transient; or of the hydraulic overpressures caused by rock creep.

For the purpose of assessing the effects of a potential earthquake occurring after closure of the disposal facility and designing the structures, particularly sealing structures, Andra considers the maximum physically possible earthquake (SMPP). The definition of the unforeseen event spectrum and the return period considered are broadly satisfactory. However, PSE-ENV considers that Andra should, before excavating the underground structures, complete its demonstration of the conservative nature of the SMPP with regard to earthquakes that may occur between 2 and 5 km below the surface, on the one hand, and, on the other hand, in relation to the assumption of the tectonic origin of the structures detected in the Triassic directly below the HLW disposal zone (commitment 2025-E3).

On the basis of its risk analysis and in view of the uncertainties linked to the state of knowledge (see GP1 review), particularly knowledge relating to the long-term evolution of the disposal facility, Andra defines disposal evolution scenarios. PSE-ENV stresses that consideration in these scenarios of a failure of the seals or premature loss of the leaktightness of the HLW disposal containers takes proper account of the uncertainties associated with the performance of the seals (see GP1 review) and the corrosion rates of these containers (see above). Besides, the definition of additional scenarios, in line with the review of the DOS, taking into account the collapse of an ILW-LL cell during the operational phase or an undetected fault in the COx, constitutes a significant advance in the post-closure safety demonstration. Therefore, PSE-ENV considers that the selection of evolution scenarios is broadly relevant for assessing the consequences of the identified risks and uncertainties for the containment capacity of the disposal system and, ultimately, for testing its robustness.

#### **4. ASSESSMENT OF OVERALL CONTAINMENT CAPACITY**

##### **Normal Evolution Scenario**

Andra assesses the overall containment capacity of the disposal system and its impact on health and the environment in respect of two complementary situations in order to cover the normal evolution range: the “baseline situation”, which corresponds to the expected evolution of the disposal facility, and the “envelope situation”, which combines conservative data and assumptions. On the basis of the results presented by Andra and those from its own modelling work, PSE-ENV considers that the NES assessment highlights the good overall containment capacity of the disposal system. The results confirm the predominance of diffusive transfers into the bedrock - a slow phenomenon - via the COx pathway, compared with the “structures” pathway (drifts and surface-to-underground links). PSE-ENV notes that the radiological health impacts remain below the protection objective (reference value of 0.25 mSv/year), or of the same order of magnitude for the maximum impact in the envelope situation. According to PSE-ENV, these assessments of health impacts in the envelope situation - a situation which probably leads to an overestimation of solute transfers - show the importance for Andra - with a view to securing margins in relation to the protection objectives - of continuing its data consolidation efforts, in particular data relating to the solubility of selenium and to the hydraulic properties of healthy COx. In addition, further information will have to be provided by Andra to confirm the absence of any significant impact of <sup>14</sup>C - the only radionuclide present in gaseous form in significant quantities in the inventory - during the hydraulic-gas transient (commitment 2025-E4). Lastly, PSE-ENV agrees that, for the normal long-term disposal evolution scenario, the impact on non-human biota is negligible.

##### **Altered Evolution Scenarios and *What-if* Scenarios**

In the event of seal failure, PSE-ENV notes that, in the baseline situation, the drift seals provide redundancy for the surface-to-underground link seals when the latter fail; and agrees that the predominance of diffusive transfer via the COx reflects the preserved good containment capacity of the disposal facility. In the envelope situation, PSE-ENV considers that the significant transfer of solutes through the structures confirms the essential role of the surface-to-underground link seals in preventing the circulation of water in the disposal facility and thus encouraging diffusive transfers via the COx. However, in this envelope situation, the maximum radiological impact in the event of the malfunction of all the seals is still of the same order of magnitude as for the NES.

In addition, PSE-ENV considers, like Andra, that the premature failure of HLW disposal containers has limited consequences in terms of the overall performance of the containment system and the health impact of the disposal facility, as long as the other components of the disposal system fulfil their safety functions.

The assessment of a What-if scenario consisting of an undetected fault in the ILW-LL disposal zone highlights the significant impact of long-lived radionuclides with low mobility (up to 22 mSv/year), and in particular actinides and their daughters. PSE-ENV notes that this impact, which must be qualified with regard to the plausibility of the scenario adopted and the severity of the underlying assumptions, remains within the order of magnitude of the protection objectives to be adopted for this type of scenario (1-20 mSv/year); according to PSE-ENV, this reflects a good level of robustness of the disposal facility in the event of the presence of a fault in the ILW-LL disposal zone. Further information is required to confirm that such a scenario in the HLW disposal zone would have no impact above this order of magnitude (commitment 2025-E6).

Furthermore, the long-term containment performance of the disposal facility in the event of the collapse of an ILW-LL cell during the operational phase illustrates the capacity of the host rock to perform its safety functions despite local degradation (requirement met of a 50-metre-thick layer of intact argillite), and thus demonstrates the robustness of the disposal system in this type of scenario.

Lastly, PSE-ENV emphasises that, given the long-term nature of Cigéo's operational phase, abandonment of the disposal facility prior to its closure, for example as a result of socio-economic upheaval, is a possible scenario that is regularly mentioned by civil society. Such a scenario, which was raised during the review of the DOS and explored by PSE-ENV in this review on the basis of co-construction work within the framework of the technical dialogue mentioned above, could give rise to lessons being learnt, for example in terms of early preventive facility closure measures in order, in particular, to limit damage to the host rock and thereby the consequences for long-term safety. It is therefore important, with this in mind, to envisage a scenario under which the disposal facility is abandoned during its operation (commitment 2025-E7).

### **Inadvertent Human Intrusion Scenarios**

The maximum radiological exposures of a driller in scenarios involving drilling at the disposal facility due to rising waste (drill core) or a plume of radioactive gas, amounting to between a few mSv and a few tens of mSv, are not prohibitive according to PSE-ENV namely given the underlying assumption of waste being brought up to the surface. Similarly, the radiological exposure associated with the use of water contaminated following the long-term transfer of radionuclides via a short-circuit caused by an abandoned and poorly sealed exploration borehole does not reach unacceptable levels (maximum of a few tens of mSv/year) with regard to the protection objective associated with this type of scenario. However, PSE-ENV considers that Andra must analyse whether additional compartments (location and number of seals) in the disposal zones could be beneficial. This point is taken up again later in this opinion.

Generally speaking, in light of Andra's assessment of all the disposal evolution scenarios selected and the results of its own modelling work, PSE-ENV considers that the disposal system, in the chosen architecture, has a good overall containment capacity and is robust with regard to the disruptive events considered and the uncertainties identified.

## **5. SENSITIVITY STUDY OF THE DISPOSAL ARCHITECTURE**

After examining the "closure structures" and "safety options" dossiers, ASN emphasised that the overall architecture of the disposal facility (length of the drifts, positioning of the disposal zones in relation to the surface-to-underground links, etc.) could provide additional safety margins after closure in the event of the failure of one or more engineered barriers. ASN therefore asked Andra to justify the architecture chosen in the construction licence application via a study of the advantages and disadvantages of different options, taking into account the safety and radiation protection-related aspects during operation and over the long term. Given that no substantiated comparison of different optimised disposal architecture options has been carried out, PSE-ENV is not in a position to comment on whether the disposal architecture chosen at the DDAC stage is optimised, without prejudging however that it is not the case.

With regard to the safety of the disposal facility after its closure, PSE-ENV considers that extending the distance between the ILW-LL disposal zone and the surface-to-underground links base from 300 m at the DOS stage to 700 m in the architecture adopted at the DDAC stage constitutes a beneficial optimisation. However, PSE-ENV stresses, as it did at the DOS stage, that the architecture chosen places an additional burden on the drift seals, the performance of which still needs to be demonstrated, by not taking advantage of the proven gain linked to the positioning of the ILW-LL disposal zone hydraulically downstream of the surface-to-underground links base. In this regard, PSE-ENV agrees that criteria other than technical criteria, in particular those relating to the adaptability of the disposal facility, may have been taken into account in the choices made. In addition, it is important for the number (reduced from 22 to 11 since the DOS stage), location and performance of the drift seals in the architecture selected at the DDAC stage to be justified in terms of their compartmentalising role in the IHIS and the redundancy of the surface-to-underground link seals in the disposal evolution scenarios, in the updated DDAC scheduled in advance of the public inquiry (commitment 2025-E8).

Lastly, PSE-ENV considered, in respect of long-term safety, the possibility of creating an additional remote shaft away from the surface-to-underground links base for flexibility purposes. The preliminary results of this exploratory approach suggest that the addition of such a shaft is conditional on demonstrating the performance of the seals.

## 6. ADAPTABILITY OF THE DISPOSAL FACILITY

With regard to the adaptability of Cigéo to the reserve inventory, the main principles of the architecture of the disposal facility adopted for spent fuel (SF) and long-lived low-level waste (LLW-LL) are similar to those established for high-level waste (HLW) and long-lived intermediate-level waste (ILW-LL) respectively. On the basis of the results of Andra's assessments and its own modelling work, PSE-ENV considers that the overall containment capacity of Cigéo should not be compromised under normal evolution conditions. In addition, PSE-ENV considers that Andra's selection of disposal evolution scenarios - though absent of *What-if* scenarios - and the results of the associated quantitative assessments allow for the robustness of the disposal of the waste from the reserve to be assessed as a first approach. However, while no prohibitive factor has been identified at this stage, a number of uncertainties - particularly concerning the solubility of selenium and the hydraulic properties of CO<sub>x</sub> - need, as with the reference inventory, to be alleviated in order to secure margins in the envelope situation. PSE-ENV therefore stresses the importance of continuing efforts to consolidate the above-mentioned data, as well as the data relating to waste from the reserve inventory, with a view to demonstrating, where necessary and in a timely manner, the safety of the disposal of that waste.

With regard to the long-term criticality risk associated with the disposal of the waste from the reserve inventory, Andra concludes that this risk is covered for LLW-LL waste packages by the studies carried out for ILW-LL packages from the reference inventory. PSE-ENV agrees with this conclusion given the much smaller quantities of FM involved. As far as SF is concerned, Andra uses disposal evolution models similar to those considered for the reference inventory, which consequently gives rise to similar comments by PSE-ENV (see above). As regards the study of models representative of the facility right after closure or more long-term models (annular geometry resulting from FM migration), the results suggest that it should be possible to demonstrate management of the criticality risk for the disposal of most types of SF. However, for the intermediate disposal evolution phase, PSE-ENV notes the absence of any margin with regard to the criticality risk for most SF, even though Andra has not considered the combination of different types of degradation of SF (deformation of fuel assemblies, partial or total loss of thickness of one of their components, etc.). In this regard, PSE-ENV recalls that, in the installations upstream of the SF disposal facility, maintaining their shape is generally the control method chosen to manage the criticality risk, insofar as the mass of FM they contain is greater, or even much greater, in the case of the most common SF, than the critical mass of FM in any geometrical configuration. PSE-ENV therefore considers that Andra will have to make substantial efforts to demonstrate the absence of a criticality risk in the intermediate SF disposal evolution phase. In addition to Andra's demonstration efforts, PSE-ENV encourages Andra to identify additional criticality risk management measures, such as reducing the mass of FM in the cells, following the example already envisaged for certain types of SF, or taking advantage of favourable characteristics with regard to the criticality risk resulting from the irradiation of assemblies (burn-up) and their ageing.

## 7. CONCLUSION

In concluding the third strand of the technical review of the DDAC dedicated to safety of the disposal facility after its closure, PSE-ENV considers that the demonstration of the post-closure safety of Cigéo has reached the level of maturity required at the stage of a DAC. PSE-ENV underscores the relevance of the approach adopted by Andra to assess the safety of Cigéo after its closure based on the examination of its containment performance *via* disposal evolution scenarios deduced from an overall satisfactory analysis of the long-term risks and uncertainties associated with the performance of its components. The assessment of the normal evolution scenario for the disposal facility points to the good containment capacity of the disposal system. However, further efforts to consolidate knowledge, particularly knowledge of the solubility of selenium and the hydraulic properties of the geological formation of the COx, are still needed to establish margins in relation to the radiation protection objectives. The seal or HLW disposal container malfunction scenarios, as well as the scenario entailing the collapse of a cell during the operational phase, which lead to degraded containment performance, predict health impacts at the same level as in the NES. These impacts may nevertheless be greater for the scenarios involving an undetected fault in the ILW-LL disposal zone or inadvertent human intrusion, without them being unacceptable in view of the very low probability of the scenarios used and the severity of their underlying assumptions. In light of all these elements, PSE-ENV considers that the disposal system, in the chosen architecture, is robust in respect of the risks and uncertainties linked to its evolution. In addition, PSE-ENV agrees that the assessments point to radiological and chemical impacts on the environment and chemical impacts on health that are very low.

However, in the absence of a substantiated comparison of several architecture options with regard to criteria relating to safety during the operational phase and after closure of the facility, as already highlighted by ASN at the end of the DOS expert assessment, PSE-ENV is not in a position to comment on whether the disposal architecture chosen at the DDAC stage has been optimised, without prejudging however that it is not the case. From the point of view of post-closure safety, PSE-ENV stresses in particular that this architecture places an additional burden on the drift seals by not taking advantage of the proven gain linked to the positioning of the ILW-LL disposal zone hydraulically downstream of the surface-to-underground links. In this regard, PSE-ENV considers that the number, location and performance of the drift seals in the chosen architecture still require justification.

Finally, although no prohibitive issue linked to post-closure safety for the waste from reserve inventory has been identified at this stage of the adaptability studies, PSE-ENV stresses that substantial efforts are still required to demonstrate that SF disposal entails no long-term criticality risk once maintaining their shape can no longer be guaranteed.

**By way of a general conclusion**, after completion of the three strands of the technical review of the DDAC, PSE-ENV emphasises the significant progress made since the DOS stage with the Cigéo safety demonstration, both in terms of consolidating the underlying knowledge base and assessing the operational and post-closure phases. PSE-ENV considers that this demonstration has reached the required level of maturity at this stage for most of its components. The complements and consolidations identified as necessary following the technical review of the DDAC should be subject to assessment appointments prior to the next major regulatory stage in the commissioning of the facility, which is currently planned by Andra for 2050 (e.g., before the start of excavation works, before the construction of the first cell...). These relate in particular to the properties of the host rock above the deep structures detected below the northern part of the HLW disposal zone; the safety of the disposal of bituminous waste; the closure of the ILW-LL cells and the operation of the HLW cells; the measures for monitoring the structures during the operational phase; and the seals. In this regard, PSE-ENV confirms that the industrial pilot phase is now essential to fulfilling and consolidating the safety demonstration, based in particular on demonstrators run on site under industrial environmental and operating conditions, with a view to commissioning the facility.

Lastly, PSE-ENV considers that the flexibility of the facility is a fundamental issue in order to guarantee the safe management of all the waste in the reference inventory, including in the event of changes to the architecture or design of the facility considered at the DAC stage. With regard to the adaptability of Cigéo in respect of the waste from the reserve inventory, PSE-ENV has not identified, at this stage of the studies, any prohibitive issue linked to the safety of the disposal of SF and LLW-LL waste. PSE-ENV recalls that in the event of plans to dispose of waste other than waste authorised by a decree issued on the basis of the dossier covered by this review, an additional safety demonstration would be required.

For the Environment Director

**Delphine PELLEGRINI**  
Deputy Director



## **Appendix**

### **Commitments made by Andra during the GP3 review in letter CG-AMOA-LET-25-0007 dated 28 May 2025**

#### **Commitment no. 2025-E1**

By the time of the next revision of the preliminary version of the safety analysis report for Cigéo, Andra will have consolidated its demonstration that there is no post-closure criticality risk:

- by justifying that the models used to study this risk cover the likely long-term evolutions of the disposal facility from a phenomenological point of view, particularly as regards the degradation of and chemical changes to the cementitious materials;
- by drawing conclusions from the criticality studies based on these models, which may have to be revised to take particular account of the phenomenology of the cementitious materials, in terms of the margins available in relation to  $k_{eff}$ .

#### **Commitment no. 2025-E2**

In the next revision of the preliminary version of the safety analysis report for Cigéo, Andra will complete the criticality safety analysis following closure of the cemented hulls and end-pieces:

- either by justifying that the model used is conservative in respect of the phenomenological evolution, for example by taking into account the possible presence of a “mixture” of water and concrete in the long term (if the model consisting of an infinite medium is adopted);
- or by demonstrating criticality risk management using a configuration similar to those for other types of ILW-LL waste after migration (water-moderated fissile material plates concentrated at the bottom of the packages or the cell).

#### **Commitment no. 2025-E3**

Prior to excavation of the underground structures, Andra will complete its demonstration of the conservative nature of the SMPP by postulating earthquakes:

- that could occur in the Paleozoic (at depths of between 2 and 5 km) below the underground construction zone;
- associated with the possible tectonic nature of the structures detected in the Triassic (at a depth of less than 2 km), below the future HLW disposal zone.

#### **Commitment no. 2025-E4**

Andra will confirm the absence of any significant impact by assessing, prior to the public inquiry, the contribution to the dose, at the outlets, of the  $^{14}\text{C}$  present in gaseous form in the disposal facility during the hydraulic-gas transient.

#### **Commitment no. 2025-E5**

With a view to the scheduled updating of the construction licence application before the public inquiry, Andra will substantiate its conclusion that there is no health risk based on compliance with regulatory quality standards, particularly drinking water standards. To this end, it will quantify, for the NES and AES, the hazard quotients (HQ) and excess lifetime cancer risk (EIR) for the toxic chemicals present at the outlets.

#### **Commitment no. 2025-E6**

In the next revision of the preliminary version of the safety analysis report for Cigéo, Andra will consolidate the assessment of the What-if “through-disposal discontinuity” scenario, taking into account a discontinuity inside the HLW disposal zone and all the mobile and less mobile radionuclides of interest, including transuranic elements and their daughters.

**Commitment no. 2025-E7**

In addition to the post-closure safety assessment in the next revision of the preliminary version of the Cigéo safety analysis report, Andra will present a scenario in which the disposal facility is abandoned during its operation. Andra will identify, where appropriate, the lessons to be learned, particularly with regard to the arrangements for any early preventive closure of the disposal facility in order to limit the consequences of such situations on long-term safety.

**Commitment no. 2025-E8**

With a view to the scheduled updating of the construction licence application prior to the public inquiry, Andra will justify the number, location and performance of the drift seals in the final architecture, and in particular any evolutions since the DOS stage. This justification will take account of the functions to be performed by the seals, particularly with regard to compartmentalisation in the event of inadvertent human intrusion.