

Montrouge, 21 May 2021

**Direction des Projets de
Déconstruction des Déchets (DP2D)**
EDF SA
154 avenue Thiers
69548 Lyon

Subject: In-depth inspection of the Chinon A2 and graphite industrial demonstrator projects

References: *in fine*

Appendix: ASN Requests

For the attention of the Director,

In accordance with the duties of the Nuclear Safety Authority (ASN) concerning the oversight of basic nuclear installations, defined in the Environment Code, chapter VI of title IX of its book V in particular, an inspection of your departments in charge of deconstruction and waste projects (DP2D) was carried out from 16 to 20 November 2020. It was performed remotely owing to the health context. It covered the management of the decommissioning projects on basic nuclear installation 153, called “Chinon A2” (CHA2), and the development of the graphite industrial demonstrator (DIG), with regard to the provisions of Article L. 593-25 of the Environment Code, which requires that you carry out the dismantling of these definitively shut down installations “*within a time frame that is as short as possible, in economically acceptable conditions*”.

The summary of the inspection is given below, along with the main requests arising from the findings made by the inspectors on this occasion, appended to this letter.

Background

This inspection was carried out as a result of the change in strategy adopted by EDF in 2016 with regard to the decommissioning programme¹ for the six first-generation gas-cooled reactors (GCR). The technical scenario envisaged up until 2015 consisted in dismantling the pressure vessels of the four reactors under water. EDF announced that it was abandoning this scenario owing to major technical difficulties. EDF thus opted for air dismantling of the pressure vessels of the six reactors and revised its overall GCR dismantling strategy. This new strategy notably introduces two “risk reduction” steps, designed to reduce the industrial risks associated with the dismantling of the reactor pressure vessels. The first consists in performing simulations and tests in the DIG, in order to fine-tune the reactor pressure vessels dismantling scenario and make the corresponding

¹ A programme is defined as being a group of related projects, the management of which is coordinated in order to derive benefits and ensure control that could not be provided by individual management. Programme-based management pays particular attention to the interdependence between projects and helps determine the optimum approach to their management. Programme-based management requires specific organisation and resources.

operations more reliable. The second corresponds to the dismantling of CHA2, the aim of which is to accumulate operating experience feedback for the subsequent dismantling of the other five reactors. The consequence of these choices is a significant extension in the decommissioning time-lines.

In March 2020, ASN issued a position statement on this strategy change, in two resolutions [1, 2]. These resolutions regulate the next steps in GCR decommissioning, notably dismantling outside the reactor pressure vessels, development of the DIG and submission of the decommissioning files. However, they do not validate the dismantling schedules for the six reactors: ASN considers that EDF must look for means of optimisation in order to reduce the time-lines in compliance with the legislative obligation of dismantling with a time-frame that is as short as possible.

An in-depth inspection of the DIG and CHA2 projects was carried out, in order to evaluate the robustness of EDF's organisation for management of these projects, which are key elements in the "risk reduction" operations.

Inspection preparation

The inspection team prepared for the inspection by assimilating the main EDF reference documents for management of its decommissioning projects, in order to gain a clearer understanding of the specific aspects of the licensee's organisation. This preparation lasted several months and was based on the licensee's voluntary handing over of all the existing documentation, with explanations where necessary. The inspectors underline the exemplary attitude of the EDF teams, who were available, transparent and reactive throughout the exercise.

At ASN's request, prior to the inspection, EDF conducted a self-evaluation of the two DIG and CHA2 projects, detailing their progress and demonstrating their correct management. The inspectors underline the quality of the report submitted at the end of this self-evaluation process. Upstream of the inspection, the licensee also organised an in-depth visit to the facilities on the Chinon site, as well as a technical meeting. These efforts improved the inspectors' understanding of the implications of these projects for EDF.

The inspectors defined an inspection strategy designed to provide a systematic evaluation of the management of these two projects, more specifically by focusing on the complex projects management disciplines (engineering, scheduling, risks and opportunities, project oversight, governance, etc.).

Strong points of the EDF approach to the performance of the CHA2 and DIG projects

The inspectors observe a positive, dynamic attitude within the project teams. They underline the competence and commitment of the personnel, both in the head office departments and on the site. This engagement by the teams is a crucial factor in the success of such projects.

The inspectors also note the pertinent technical choices made to ensure successful complex decommissioning on an industrial scale. These choices notably include investment in an industrial demonstrator, in digital modelling, in the creation of a decommissioning files coordination office and in analysis of operating experience feedback, in particular that obtained from other countries. EDF addressed the subject of technical expertise by developing the Graphitic subsidiary in 2019. It also carries out detailed monitoring of critical in-house skills and the technical capabilities of the external industrial fabric.

Most of the complex project management processes, such as purchasing, risk management, cost estimation and management control, have been implemented and are satisfactorily applied. The inspectors were encouraged to observe extensive communication within the teams and the periodic

presentation of the progress of the projects to the governance body, which tests certain project proposals².

The development of an internal guide for the production and maturity evaluation of basic engineering and the ongoing development of a similar guide for the Front-End Engineering Design (FEED) should contribute to improving the evaluation of project maturity.

Areas of improvement identified by the inspectors

The inspectors consider that EDF should make a more detailed study of certain means of reducing the time-scale of the “risk reduction” steps, for example the level of flexibility in the design and operation of the dismantling platform³, which ultimately could potentially reduce the time needed to analyse the lessons learned from the dismantling of the Chinon A2 reactor pressure vessel. The extension of the scope of the industrial demonstrator is also a means of reducing the scope of the second “risk reduction” step and thus its duration.

The management of the GCR decommissioning programme, which includes the CHA2 and DIG projects, needs to be reinforced, to take better account of the inter-dependence between projects. Particular attention needs to be paid to identifying and monitoring cross-cutting technical hypotheses, but also the deliverables at the interfaces. With regard to risk management, the work to identify risks with an impact on the GCR decommissioning programme as a whole must be taken further. A more detailed evaluation of the robustness of the information modelling strategy also needs to be carried out.

A regular review of the hypotheses underpinning the projects, their objectives and, more generally, the GCR decommissioning programme, would appear to be necessary given the duration of the projects and the inter-dependence between them. It would enable the strategy to be adjusted according to the progress of the "risk reduction" operations, developments in the project input data and the available knowledge and techniques.

With regard to the graphite waste management strategy, the ASN opinion of 8 August 2020 – in preparation for the drafting of the next edition of the National Radioactive Materials and Waste Management Plan (PNGMDR) [5] – recalled that the Aube waste repository (CSA) was licensed and started up to receive “*solid radioactive waste with a short or intermediate half-life and low to medium specific activity*”, given that the long-lived radionuclides are only present in negligible quantities as “associated” substances. ASN therefore considered that if the use of the CSA for disposal of LLW-LL waste were to be envisaged in the future, a preliminary procedure to modify the CSA authorisation decree would be needed. As graphite waste is LLW-LL, EDF must continue its studies with the aim of improving the characterisation of this waste and defining a management scenario compatible with the regulatory framework which does not currently allow its disposal in the CSA.

With regard to the project management processes, EDF must improve its scheduling, the oversight of this scheduling and the forward planning of deadlines. The inspectors consider that this topic is a priority. Moreover, evaluating the maturity of the projects could be developed further in order to improve expertise in this field. The process of identifying opportunities could benefit from being better managed. Finally, the roles of project owner and project manager need to be clarified, in order to specify the respective responsibilities and check the skills required of each player. More generally,

² Testing the project consists in querying the main choices made and the associated hypotheses, in order to evaluate their relevance with regard to the Owner’s requirements, notably that of dismantling the BNI as rapidly as possible at an economically acceptable cost, in accordance with the provisions of Article L.593-25 of the Environment Code.

³ This platform is a complex item of equipment, specifically designed for dismantling of the reactor vessel. It is thus an essential component in ensuring successful dismantling.

the project oversight role needs to be reinforced and given greater importance in the EDF organisation.

Conclusion

Following this project inspection approach, the inspectors have greater confidence in the licensee's ability to run the CHA2 and DIG projects. The inspectors however underline the fact that the means of optimising the time-frames for the "risk reduction" steps should be evaluated in greater depth, with sufficient advance planning regarding certain choices which determine their performance. The inspectors finally conclude that the schedules for these projects and the GCR decommissioning programme need to be regularly tested.

Please find attached to this letter the requests resulting from this inspection.

Kindly send me your comments and answers within a maximum of twelve months. With regard to the commitments you will be required to make, I ask that you identify them clearly and indicate a completion date for each one.

Yours sincerely,

Christophe Quintin

APPENDIX TO LETTER CODEP-DRC-2021-003005

A. Corrective action requests

1. Control of project management processes

Schedule management

EDF has implemented a hierarchy of schedules according to the intended management objective, which is satisfactory. The integrated project schedule⁴ constitutes an essential reference for project management and decision-making by the project manager. It is therefore important to verify its technical quality and its reliability, which may be measured by means of criteria and indicators, such as:

- the number of tasks;
- the tasks balance between the various project management disciplines (engineering, procurement, fabrication, works, etc.) and the various stages of the project (basic engineering, APC⁵, FEED, performance), across its entire perimeter;
- the identification of the associated interfaces;
- the structure of the schedule (number and type of links between the tasks, scheduling/sequencing, etc.);
- the realistic nature of the task durations;
- the appropriateness of the buffer times and the margins that guarantee the reliability of the critical deadlines, more particularly their position in the schedule.

In addition, a baseline⁶ is associated with the integrated project schedule and is used to measure project progress. This baseline is intended to reflect the strategy approved by the governance board and to constitute a lasting reference.

EDF has not defined any inspection criteria to evaluate the quality of the integrated project schedule. The checks carried out by the inspectors however reveal significant shortcomings with respect to the above-mentioned criteria and indicators. These shortcomings more particularly call into question the reliability of the critical path and the licensee's ability to effectively manage the project.

The baseline undergoes two annual revisions, which means that compliance with the initial schedule cannot be monitored over time. The EDF project management system however states that the baseline is only revised when an event leads to a major deviation during performance of the project. The licensee stated that it had not recorded any significant variation in its strategy since its revision in 2016. In addition, the licensee's project management system make no provision for independent internal monitoring of the schedule so that it can be validated following a major revision, even though this practice was recommended to ensure the continued applicability of the baseline.

With regard to the governance schedule⁷, the licensee's project management system make provision for the use of a level one schedule. The inspectors however find that the less detailed level zero schedule is mainly used for this purpose. The inspectors also consider that the co-existence of two

⁴ The integrated project schedule covers the entire scope of the project, its main external interfaces and all the contributing disciplines (engineering, purchasing, manufacturing, construction, commissioning, operation) in a balanced manner and with sufficient detail to identify the interdependences and justify the overall sequencing of the project and its duration. It does not replace the detailed schedules of each discipline.

⁵ APC: consolidated preliminary design

⁶ The basic reference of the schedule is the reference schedule against which the progress of tasks is measured. Following updating of the schedule, any deviations from this reference shall be identified and analysed, in order to define any countermeasures needed to meet the project's contractual deadlines.

⁷ The governance schedule is a project summary schedule periodically presented to the governance bodies so that they can monitor the progress of the project.

governance schedules means that there is a risk of inconsistency, in particular because the level one schedule is not automatically constructed from the integrated project schedule, which serves to increase this risk. There should thus be a single, formally referenced governance schedule, defined and updated consistently with the integrated project schedule.

Therefore, although schedule management is an essential discipline in managing a complex project, the inspectors consider that the process implemented by EDF for the DIG and CHA2 projects needs to be improved so that it is in line with current best practices.

A1. I would therefore ask you to revise and then send me your schedules management procedure, which shall:

- **include technical criteria for checking the quality of the integrated project schedule,**
- **define the provisions for ensuring the lasting applicability of the integrated project schedule baseline,**
- **specify the methods for producing the governance schedule, notably by reducing the risks of inconsistency with the other scheduling levels.**

For each of the DIG and CHA2 projects, you will therefore produce an integrated project schedule and a governance schedule, complying with this procedure.

The estimate of the durations of the CHA2 integrated project schedule tasks is backed up by engineering studies, themselves confirmed by operating experience feedback data. This approach is satisfactory. However, the main hypotheses are not centralised and monitored over time and the risks are not addressed by means of specific margins. With regard to the tasks in the DIG project integrated schedule, certain durations, more particularly in terms of performance of tests, were estimated on the basis of expert opinion, which makes this schedule potentially less reliable. Considerable work is still to be done to develop this schedule and make it more reliable, before operation of the demonstrator begins.

A2. I would ask you to document and monitor the main hypotheses adopted for constructing the integrated schedules for the DIG and CHA2 projects, notably those concerning durations, and to evaluate the corresponding uncertainties.

Project management

Every year, the project management places performance target contracts with the projects concerned, constituting their management milestones. These milestones are regularly examined by the governance body, with the transmission of a corresponding visual indicator. Regular communication by the projects with their suppliers and the in-house teams enables the main difficulties to be identified, thereby improving the reliability of these indicators.

The inspectors however find that the current performance targets do not cover certain important interim deadlines. Management of these deadlines implies planning ahead for the main deliverables needed to meet them, identifying them as management milestones and monitoring their progress. This is particularly the case with the engineering deliverables, owing to the current preponderance of studies in the DIG and CHA2 projects.

A3. I would therefore ask you:

- a. to consolidate the identification and, across the perimeter of the DIG and CHA2 projects, to monitor all important interim deadlines,**
- b. for these deadlines, to identify the deliverables to be produced upstream and to monitor their progress,**

Taking account of my request B1, you will inform me of the measures adopted for this purpose and will send me the tool selected for management of the two projects.

Deadline forecasting and implementation of project control

The inspectors find that EDF makes no deadline forecasts and does not monitor consumption of schedule margins, even though this could provide useful information.

A4. I would ask you to produce forecasts of the project's key deadlines, notably to back up the provisions you will be submitting in response to requests A1, A3, B1 and B2.

Management of changes and of the interfaces

The projects inspected have interfaces, both between work packages within a given project and between different projects. The projects do not however comprise particular traceability to prove that these interfaces are managed. For example, the inspectors find that the integrated project schedules fail to show certain interfaces, which means that it is impossible to demonstrate that they are addressed satisfactorily.

The inspectors verified a change with serious implications, concerning the modification of the industrial demonstrator slab. This was correctly documented by the Project Owner support personnel and then validated by the Project Owner. However, the corresponding variation in the project's reference budget was not formally stipulated. On other projects, the inspectors found that variations in cost estimates were insufficiently documented. Scheduling variations are recorded in the scheduling software but are not systematically analysed to assess whether a revision of the baseline is required. EDF nonetheless indicates that a revision is made every year, based on the recorded data.

Appropriate traceability is required to control the impact of changes and combinations of changes on the project baseline, with integration of the scope, the budget and the schedule. This traceability also facilitates independent checks and ensures that the main data are retained even in the event of departure by personnel.

The inspectors find that the change management process is not formally set out, with the licensee's objective simply being to update the volume of engineering hours needed. Thus, although a modification requiring a variation of several hundred hours of engineering is written up on a sheet, a less significant variation in the volume of engineering hours simply leads to direct updating of the scheduling software module concerned. Consequently, the DP2D project management system makes no provision for a change evaluation criterion integrating the scope, budget and schedule, considering both the direct consequences on the work package concerned and the indirect consequences on the interfaced work packages.

A5. I would ask you to complete your project management system with a formalised change and interfaces management process, documenting the interfaces between work packages and improving the traceability of variations in scope, schedules and budget, so that control of the integrated project baseline can be demonstrated at all times. You will send me the corresponding documentation.

Evaluation of project technical maturity

❖ Evaluation process

When dealing with work packages of limited complexity, EDF performs the studies up to the basic engineering stage, possibly up to the APC stage, and then entrusts the studies up to the FEED stage and the performance studies to the contractor, with a view to placing contracts for the objectives. With regard to complex tasks, following the strategy change decided on in 2016 and the creation of subsidiaries in 2019, EDF modified its contractualisation strategy, by bringing the FEED step in-house within its subsidiaries, in order to reduce the contractual risks. The DP2D has thus begun to draft a guide specifying a study at this stage for its subsidiaries, following on from that produced in 2019 for the basic engineering stage. The inspectors have a favourable opinion of this initiative.

These guides only concern a work package which is a very limited part of the project scope. To date, the licensee does not have a process for evaluating the overall maturity of the entire scope of the project, whereas certain work packages interface with each other. Nor does the organisation provide for independent internal checks, such as peer reviews. These inspections are recommended⁸ so that maturity evaluations can be conducted at the most important steps in the project, in particular the engagement milestones concerning the entire scope of the project according to the licensee's project management system, in order to reduce errors in the corresponding decision taken by the governance. For example, the inspectors note the absence of a maturity evaluation milestone for the CHA2 project upstream of submission of the decommissioning file, scheduled for 2022, and for the DIG project, in order to validate all the studies, some of which are currently at the basic engineering stage, whereas start-up of operation of the industrial demonstrator is planned for 2022. The licensee confirmed that considerable work was still to be completed in the run-up to this deadline.

A6. In line with request A7 of letter [3], I would ask you to determine a formal procedure for project maturity evaluation, using internal inspections independent of the complex project management disciplines. You will send me this procedure.

A7. I would ask you to define engagement milestones covering the entire scope of the DIG and CHA2 projects and to programme the corresponding maturity evaluations.

The inspectors checked the specifications associated with the test and 3D simulation programme to be delivered by the Graphitech company. They find that they do not mention any requirement for the definition of tests in degraded modes⁹ even though this is an important issue in the project. EDF however confirms that the work currently in progress covers this requirement.

⁸ Notably the *Front-End Loading* approach, more specifically implemented in the oil industry, which aims to evaluate the technical maturity of the project.

⁹ Degraded modes correspond to situations resulting from foreseeable technical problems (tool failure, falling objects, jammed parts, etc.)

A8. I would ask you to bring your specifications into line with the work required for the development of degraded mode tests.

❖ *Information modelling and management strategy*

EDF has decided to invest in information modelling techniques to reinforce its industrial decommissioning capability for the reactors definitively shut down. These techniques have notably proven their benefit in the construction sector (*Building Information Modelling* or BIM) in reducing errors and speeding up the design and construction of works¹⁰. This approach aims to compile and analyse configured digital data and represents a major organisational development, even for organisations with experience of computer aided digital design. EDF thus devoted a project, called *Dismantling Information Modelling* (DIM), to the development of these techniques and the related organisation.

These digital techniques entail technical, organisational and contractual issues that need to be anticipated by the project owner in order to take full advantage of this approach. The inspectors verified the DIG, CHA2 and DIM projects with regard to these issues.

Concerning the DIG project, the licensee stated that it would be developing design studies for the FEED stage of the dismantling platform using a DIM approach. Although this work is scheduled to begin as of the end of 2023, there is as yet no documented strategy concerning the main issues to be anticipated and managed, whether technical or contractual (core technical capabilities of Graphitech and of the suppliers, early contract placement with these latter, ability to ensure integrated digital collaboration, etc.).

Concerning the CHA2 project, the interior of the reactor vessel is not accessible and the licensee carried out its digitisation work using the available photos and drawings. Although it comprises detailed geometrical data, this digital mock-up contains a lower level of configured information than the other digital mock-ups produced on the facility. This weakness can limit the possibility of future use of the data and thus the benefits of the DIM.

The inspectors asked whether the licensee intended to model the dismantling platform interfacing with this mock-up, to define the configuration states at the various stages in dismantling and, more generally, to produce advanced digital simulations. The intended uses have not yet been precisely documented.

With regard to the DIM project, the DIM development and maturity levels have not been formally evaluated. A review is under way regarding the requirements for interoperability between software, data management and data durability.

The inspectors consider that EDF's decision to invest in the DIM project is satisfactory. They do however underline the importance for the dismantling programme and thus the absolute need for satisfactory management.

¹⁰ One of the characteristics of the BIM approach is discussions around virtual models of structures created digitally. These models facilitate the design, analysis and inspection.

A9. Regarding the DIM project, I would ask you:

- a. to send me a detailed DIM development strategy before 31 December 2022, for the purposes of the CHA2 and DIG projects, more specifically evaluating:**
 - **its target progress at the various stages in the CHA2 and DIG projects, whenever possible considering the criteria recommended by the state of the art in the BIM (level of maturity, level of development, exchange format, etc.),**
 - **all the technical, organisational and contractual issues identified by the project owner for these projects, specifying the relevant requirements and the main corresponding management provisions;**
- b. before transmission to ASN, to carry out an independent evaluation of this information modelling and management strategy. You will more particularly evaluate advance planning for implementation of this strategy in order to derive full benefit for the dismantling programme, notably with a view to reducing the overall dismantling time-frame. This evaluation will in particular examine the analysis you produce in response to my request A18. You will send me the conclusions of this evaluation, as well as the corresponding action plan.**

❖ *Graphite waste management strategy*

The dismantling of the six GCR reactor vessels will produce about 15,000 metric tons of graphite waste. This waste is low-level, long-lived waste (LLW-LL). EDF's reference strategy for the management of the graphite waste to be produced by dismantling of the Chinon A2 reactor vessel did not appear to be compatible with the applicable regulatory framework. EDF envisages disposing of the graphite waste from the Chinon A2 reactor in the Aube repository (CSA), provided that its compatibility with this facility's safety case can be demonstrated. In its resolution of 3 March 2020 [2], ASN states that the acceptability of the LLW-LL waste in the CSA is anything but certain and instructed EDF to present a strategy in its future dismantling files that is compatible with the absence of an available disposal solution. Moreover, in its opinion of 6 August 2020 [5], ASN stated that it "*generally considers that LLW-LL waste must be disposed of in facilities duly authorised for this purpose. ASN therefore considers that if the use of the CSA for disposal of LLW-LL waste were to be envisaged in the future, a preliminary procedure to modify the CSA authorisation decree would be needed and the CSA's ability to house the waste for which it is currently designed should not be compromised*".

The licensee has not yet analysed the impact of this incompatibility on its reference strategy. The change in disposal solution may for example require interim storage if the management route is not available or a modification of the conditioning process for disposal or storage. These changes can lead to a modification of the dismantling processes for the CHA2 reactor vessel. The updating of the reference strategy may thus entail changes to the test programme on the industrial demonstrator.

The inspectors also observed that the project organisation note was obsolete and did not include the major decision-making milestones, such as the decision to build a new storage facility for the graphite waste. Nor did it mention the R&D studies to be carried out for conditioning of this waste, even though this was stipulated in Article D. 542-76 of the Environment Code. The licensee has undertaken to update it in 2021.

A10. I would therefore ask you:

- a. to take account of the currently applicable regulatory framework, which does not allow the disposal of graphite waste in the CSA, when defining the reference strategy for management of the CHA2 graphite waste, in response to Article 2 of the ASN resolution of 3 March 2020 [2];
- b. to enclose a detailed note with the Chinon A2 dismantling file specifying the studies conducted for implementation of an appropriate conditioning process, as well as the alternative strategies studied. You will explain the main corresponding milestones;
- c. to evaluate the impact of the ASN opinion [5] on the dismantling processes adopted for the CHA2 project and the corresponding test programme under development for the DIG project. You will inform me of the conclusions of your evaluation;
- d. following the revision of your reference strategy for management of CHA2 graphite waste, to update the documentation for the DIG and CHA2 graphite waste management projects (schedule, risks register, project management plan, etc.).

Management of opportunities

The inspectors checked the risks and opportunities management process, notably the corresponding register for the DIG and CHA2 projects. With regard to risk management, the inspectors consider that the process is correctly implemented. The inspectors did however find that the register contained no opportunities.

A11. I would ask you to implement the opportunities identification process for the DIG and CHA2 projects and to record them in the corresponding register.

2. Management of project organisation

Roles and working of the Owner and Project Manager PM)

Article L. 593-25 of the Environment Code states that basic nuclear installations must be dismantled as rapidly as possible, in economically acceptable conditions. ASN therefore considers that these projects must be schedule-driven¹¹, which requires an appropriate organisation.

In the group's project management system, EDF documents general provisions concerning project management. This documentation is not applied to the DIG and CHA2 projects, dealing as it does primarily with the working of the Owner and the PM.

With regard to the Owner, the checks carried out by the inspectors show that the DP2D pools the roles of the Owner and PM, without distinction. The state of the art in complex projects management recommends differentiating between them, even if these players are all within the same company, in order to clarify their respective responsibilities. The inspectors also noted that EDF envisages reorganising its engineering division, in order to reinforce DP2D's ability to perform its studies in-house. In this context, the inspectors underline the need to clarify and distinguish between the roles of Owner and PM within the DP2D.

With regard to the Owner, the DP2D adopts a different way of working than that described in its documentation and one that is not defined.

¹¹ This method of management leads to trade-offs being made, giving priority to compliance with schedules, even if this leads to higher costs. The extra costs must of course remain acceptable, as stipulated in Article L. 593-25 of the Environment Code. They must be evaluated conservatively, updated regularly and be covered by provisions, as stipulated in Articles L. 594-1 et seq. of the Environment Code.

A12. I would ask you to clarify the roles of owner and project manager and to distinguish between the corresponding personnel within the EDF teams. Following its revision and taking account of my request B6, you will send me the project management documentation concerned and the new organisation notes for the DIG and CHA2 projects.

Graphitech

In 2019, EDF created its Graphitech subsidiary to reinforce its technical capabilities and be able to carry out the GCR dismantling programme on an industrial scale. In accordance with the specifications produced by EDF for this service, Graphitech officially acts as PM for the definition and performance of tests on the industrial demonstrator. This role could be carried over to the subsequent steps (design studies and placement of contracts for the platform, coordination of suppliers, operation of the platform and coordination of the contractors in charge of the dismantling operations). Graphitech thus plays a central role in the success of the programme, in that it will propose to the MOA which tests are to be performed to qualify the technical solutions adopted for dismantling of the first reactor in the programme. The continued development of the DIG project currently depends on major deliverables to be submitted by Graphitech in 2021, which more particularly include the 3D test and simulation programmes.

The inspectors checked EDF's evaluation of Graphitech's technical capabilities as PM, for the service in progress. EDF did not produce a formal evaluation for this purpose, as this more specifically dealt with skills and a management system that were in-house. The inspectors consider that the recent creation of the Graphitech company in 2019 increases the importance of this evaluation. Finally, Graphitech will be required to act as PM with expertise in the techniques and organisations relative to the DIM project, which were also not evaluated by EDF.

A13. I would ask you to perform an evaluation of Graphitech's technical capabilities in its role as PM, for the performance of the duties you contracted to it (in-house skills and management system), notably including the additional requirements needed to implement the DIM. You will inform me of the conclusions of your evaluation and the action plan selected.

The inspectors found that the volume of working hours contracted with Graphitech was particularly high over the period 2020-2024, and was the most important engineering budget across the two projects. However, the owner of the DIG project only has the work package owner to coordinate it, with the support of the project head and an engineering resource from DP2D. Sufficient personnel levels at the project owner are required in order to oversee the project manager.

A14. As part of an independent internal inspection, covered by my request A6, and before confirming the maturity of the project, covered by my request A7, I would ask you to evaluate the adequacy of the human resources allocated to the owner for the DIG project. You will inform me of the conclusions and any improvement measures decided on.

3. Opportunities to reduce the duration of the "risk reduction" operations

Two-stage risk reduction strategy

In 2017, EDF completed the basic engineering level studies concerning the DIG project. A basic engineering stage aims to evaluate options and then select one according to criteria set by the Owner, for its subsequent development during the FEED stage. The inspectors verified how the Owner considered the provisions of Article L. 593-25 of the Environment Code when defining these criteria. The inspectors noted that during this basic engineering stage, the options selected in 2016 were not tested with a view to ensuring the shortest possible dismantling time-frames. The current choice of selecting a two-stage risk reduction strategy, notably the second stage which will require

that the majority of the CHA2 reactor vessel be dismantled before beginning the dismantling of the vessels of the subsequent reactors, increases the time-frame of the dismantling programme. The licensee justifies this second stage by the need, on the one hand, to finalise risk reduction by means of operations in real conditions, as well as to validate the technical options chosen and to optimise them where possible and, on the other, to confirm the design and actual performance of the platform (throughput, environmental control, etc.), owing to the particular constraints arising from the nuclear environment. The inspectors verified that the investigations conducted during the basic engineering stage were sufficiently detailed.

❖ *Suitability of a flexible design for the dismantling platform*

The licensee stated that contingencies could be encountered during operation of the dismantling platform on the Chinon A2 reactor vessel. This is why the licensee envisages waiting for the end of removal of the graphite blocks from the vessel in order to gain the maximum operating experience feedback before deciding on any changes to the design of this equipment and before continuing with the dismantling programme. The inspectors checked whether the licensee had evaluated the suitability of a flexible platform design, as of the basic engineering stage and independently of the optimisations to be made during the FEED one. This flexibility requirement would enable the platform to be adapted to the foreseeable contingencies during operation. It could help reduce the length of the second “risk reduction” stage, or even do away with it completely if the design of the platform is flexible enough. Thus, although the platform simulator (tool-holder structure) to be used in the industrial demonstrator for the tests is already designed with a flexibility requirement, which leads in practice to modular equipment, this approach was not considered at this stage for the design of the platform. A modular design could offer benefits¹².

A15. I would ask you to examine the possibility of opting for a flexibility requirement in the design and operation of the dismantling platform, in order to reduce the length of the second “risk reduction” stage.

❖ *Scope of risk reduction on the industrial demonstrator*

The configurations for which the risks cannot be removed on the industrial demonstrator (stage 1) and requiring tests in real conditions on Chinon A2 (stage 2) are not precisely detailed or justified. The importance and the duration of this second stage are therefore not formally justified, even though they determine the schedule for the dismantling programme. For example, the inspectors find that the reduction in visibility is a constraint that the licensee only intends to evaluate as of stage 2. The inspectors checked whether the possibility of testing configurations on the industrial demonstrator with reduced visibility had been studied for the possible performance of tests during stage 1, thus reducing the duration and risks of stage 2 accordingly. This study was not carried out, even though accurately reproducing the environment in order to validate the tests on an industrial demonstrator is of major importance here, indeed identified as such in the state of the art¹³. The inspectors also note that a limited number of platform functions would be tested on the industrial demonstrator, with the tests of the other functions being carried over to stage 2 by default.

The study of a flexible platform design, as covered by my request A15, increases the interest of performing a second study on the increase in the scope of the configurations covered during stage 1. The study of a flexible design notably aims to reduce the need for experience feedback from the

¹² Modularisation of installations is a concept widely used in the oil and gas industries, which derive benefits such as reduced complexity and interfaces, simplification of the installation and commissioning steps, shortening of schedules, replacement of modules (enabling new solutions to be implemented for the system functions), reduced costs at programme level by standardisation of the design model, thanks to its flexibility.

¹³ In particular standard NF ISO 16290, relating to the definition of technology maturity levels and their evaluation criteria.

operations to be carried out on Chinon A2. If the scope of stage 1 is also extended to deal with a greater number of configurations, the combined results of these two studies could significantly shorten the overall time-frame of the dismantling programme.

A16. I would ask you to examine the possibility of expanding the scope of the configurations covered by the industrial demonstrator, to include the additional configurations currently provided for in the second stage, notably taking account of my request A15, in order to shorten the time-frame of the dismantling programme. Following your analysis, you will specify and justify the configurations selected for the second stage.

- ❖ *Justification of durations for processing operating experience feedback from the dismantling of Chinon A2*

With regard to processing experience feedback from the dismantling operations to be performed on Chinon A2, the inspectors find that the licensee chooses significant durations, varying from 5 to 11 years, depending on the dismantling stages considered. Owing to these durations, the licensee rules out the possibility of bringing forward the start of dismantling of the subsequent reactors. Although the duration of the schedule for processing operating experience feedback is presented in the dismantling strategy file, it is not justified by any particular analysis (documentation of the main hypotheses, study of opportunities to reduce these durations, identification of risks associated with the schedule, anticipation of issues, detailed schedule justifying the sequencing, etc.).

A17. I would therefore ask you:

- a- **for a formal detailed analysis justifying the duration of the schedule for processing operating experience feedback from the dismantling of Chinon A2,**
- b- **to study the opportunities liable to reduce this duration.**

- ❖ *Testing of the schedules through development of the DIM*

The design and contract placement studies for the decommissioning platform are scheduled as of 2023, for a period of four years. This period was not documented and was estimated on the basis of an expert opinion. Performance of these studies will be interfaced with the test programme, which will itself be carried out simultaneously on the industrial demonstrator. The licensee has not tested this duration by evaluating the benefits of implementing the DIM project, notably by placing contracts with the suppliers as early as possible and by developing a collaborative approach with them, in order to speed up processing of changes and the digital design of the equipment.

In addition, with regard to the schedule for processing operating experience feedback from Chinon A2 dismantling, the inspectors also noted that this duration has not been tested thanks to development of the DIM.

A18. I would ask you to test the schedules for the CHA2 and DIG projects, and the GCR reactors decommissioning programme, by implementing the DIM project, while more particularly evaluating its potential for speeding up the programme given the state of the art on the BIM.

- ❖ *Increased parallel performance of tests in the industrial demonstrator*

The inspectors checked the logic used to define the industrial demonstrator schedule. Every year, the licensee intends to concurrently perform the test programmes on two families of mock-ups, from

among the six defined for the needs of the Chinon A2 project. This rate is notably restricted by the fact that there is only one platform simulator.

Logic alternatives were not introduced during the basic engineering stage in order to reduce the duration of step 1, notably considering any additional resources (for example, a second platform simulator) and a different organisation (shift working, additional parallelisation, etc.).

The stakes of these evaluations are high, owing to their potential impact on the decommissioning programme schedule.

A19. I would ask you to evaluate the possibility of reinforcing the organisation and the resources of the industrial demonstrator, in order to shorten the schedules of the DIG and CHA2 projects.

- ❖ *Evaluation of the benefits of the “risk reduction” strategy for the other reactors in the decommissioning programme*

A Monte Carlo type analysis was run to evaluate the technical risks associated with the dismantling of the Chinon A2 reactor vessel. It is also valid for the other GCR reactors. This quantitative analysis indicates that these technical risks will fall significantly thanks to the tests performed on the industrial demonstrator and then the dismantling of the Chinon A2 reactor vessel, which justifies the two-stage “risk reduction” programme. However, this analysis does not take account of the risks specific to the vessels of the other reactors. Consequently, the benefits of the industrial demonstrator and the dismantling of the CHA2 reactor vessel have not yet been entirely justified for the other reactors in the programme.

In 2018, EDF however developed an analysis of the compatibility of the industrial demonstrator with the dismantling needs of the other GCR reactor vessels, which is satisfactory. This study must be taken further, notably to provide a more precise evaluation of the benefits of the industrial demonstrator for the other reactors.

A20. I would ask you to provide a detailed evaluation and justification of the benefits of the “risk reduction” programme for the other reactors in the programme, incorporating the risks specific to each reactor and highlighting the risks for which operating experience feedback from the tests performed for the CHA2 project will be sufficient and those which will require additional tests on the industrial demonstrator.

A21. For each of my requests A15 to A20, I would ask you to send me a sufficiently detailed technical note before 31 December 2022, so that it can be assessed. Your decision-making criteria shall notably take account of the request made in ASN’s letter [4] not to exceed the period of 15 years between opening of the vessels of the first and last reactors. On completion of your review, you will update your two-stage risk reduction strategy in your file.

4. Management of the gas-cooled reactor decommissioning programme

Management of opportunities and risks

The opportunities and risks identified by each project are ranked. The risks with a generic impact (level zero risks) are transferred to the programme for management. The inspectors found that EDF has not yet identified any level zero risks, whereas the DIG and CHA2 projects are programme precursors. Similarly, no generic opportunities have been identified.

A22. For the DIG and CHA2 projects, I would ask you to identify the “level zero” opportunities and risks, paying particular attention to the opportunities liable to shorten the programme schedule. You will inform me of the main level zero opportunities and risks identified accordingly.

Specific aspects of a long schedule programme

❖ Documentation of the strategy and provisions for management of a long schedule programme

The GCR reactor dismantling projects are complex and are coordinated in a programme entailing a long schedule. EDF currently envisages its completion by the end of the 21st century. A schedule such as this requires anticipation of the problems that will inevitably arise over the long term, such as obsolescence of technologies, data conservation or the evaluation of technical capabilities within the industrial fabric and the subcontractors. The checks carried out by the inspectors show that EDF is fully aware of these issues and an appropriate process to examine them is ongoing. However, EDF does not specifically document this strategy, nor the provisions adopted to manage the corresponding issues and challenges. The DIM, which is still under development, could be a particular means of addressing a number of these challenges. However, the DIM project is for the time being focusing on short-term challenges.

A23. In the management of your programme, I would ask you to formally set out the specific provisions for management of a long schedule. I would ask you to examine whether it is opportune to benchmark the industrial firms faced with the management of complex programmes over a lengthy schedule in order to reinforce your strategy. You will inform me of the outcome of any steps you have decided on along these lines.

❖ Governance

EDF confirmed its desire to review the programme schedule when certain technical choices and the corresponding opportunities have been consolidated and when feedback is available and has been analysed (test results, end of Chinon A2 dismantling phases). The hypotheses in support of the dismantling scenarios, on which the programme schedule is notably based, are indeed subject to change. The licensee's governance does not however at present make provision for an in-depth periodic review of these hypotheses in order to test the programme strategy and its master schedule. The inspectors do however note the concept of a “review milestone” included by EDF in its dismantling strategy, with the aim of taking a fresh look at the programme schedule.

A24. I would ask you to set up a periodic, in-depth reassessment of the main hypotheses of the GCR reactors dismantling programme and the corresponding support projects, notably to test its overall schedule.

B. Additional information

1. Control of project management processes

Project management

The inspectors find that, even if the interim deliverables and milestones are on the whole scheduled and that their attainment is overseen by the operational entities within the projects, the licensee does not adopt the use of tools¹⁴ recommended for this purpose by state of the art complex project management.

B1. In addition to my request A3, I would ask you to examine whether it is opportune to supplement your approach with the use of new and simple tools recommended by the state of the art, to reinforce the oversight and management of your projects.

Deadline forecasting and project oversight analysis

For the “engineering” and “works” disciplines, the inspectors checked the project control process implemented, through application of the earned value management (EVM) method¹⁵. The inspectors find that this method is implemented across the scheduled scope and that schedule deviations¹⁶ are identified, which is satisfactory. On the other hand, these deviations do not appear to be sufficiently analysed and productivity is not evaluated. EDF makes no scheduling forecasts and simplifies those regarding estimated costs at completion for the year in progress and at the end of the project. The inspectors checked the engineering schedule, which appears to be insufficiently detailed, with task durations that are too long to allow such forecasts. Management of the projects does not therefore derive full benefit from the EVM method, in particular for schedule and cost forecasts.

B2. In addition to my request A4, I would ask you to examine whether it is opportune to make more detailed use of the earned value management method in order to consolidate the deadline and cost forecasts. You will inform me of your conclusions.

Role of project functions

In certain industries implementing complex projects, the associated organisations have a project control manager function to provide the project manager with strategic support. These organisations also assign particular roles and responsibilities to the project functions (scheduler, risk manager, cost controller), for this purpose. The inspectors found no such practices at EDF for organisation of the DIG and CHA2 projects.

B3. I would ask you to examine whether it is opportune to reinforce the project function roles (scheduler, risk manager, operational management controller) in order to develop an integrated vision to support the work package owners and the project manager in their management work. You will inform me of your conclusions.

Evaluation of project technical maturity

¹⁴ The convergence plan, monitoring of consumption of margins, the time-time diagram and the earliest and latest S curves are examples of tools recommended for this purpose.

¹⁵ This method aims to incorporate information concerning the scope, cost and schedule of the project, to measure its performance in terms of progress.

¹⁶ The schedule deviation is a performance metric for measuring compliance with a project schedule. This notion is important in the implementation of the project control process.

❖ *Evaluation process*

The DP2D has started to draft a guide informing its subsidiaries of its requirements concerning the FEED stage studies, following on from that produced in 2019 for the basic engineering stage. The inspectors have a favourable opinion of this initiative.

B4. In addition to my request A6, I would ask you:

- a. **to indicate the deadline for distribution of the guide for creation and evaluation of the maturity of an FEED stage file, and then transmit it to me.**
- b. **to evaluate whether it is opportune to produce a similar guide for the consolidated preliminary design (APC) stage, which is – according to your terminology – an interim stage between the basic engineering and the FEED.**

❖ *Information modelling and management strategy*

During the course of the inspection, EDF stated that it had initiated discussions with the French nuclear licensees concerning BIM techniques. The inspectors did not however identify any particular benchmarking carried out with non-nuclear industries, notably those which effectively derive benefit from these tools in terms of shortening the schedules of complex projects.

B5. In addition to my request A9, I would ask you to examine whether it is opportune to carry out benchmarking of the industries which have used a BIM approach, in order to reinforce your strategy.

2. Management of project organisation

Roles and working of the Owner and Project Manager

The inspectors conclude that it is necessary to clearly define the roles and responsibilities of the owner and the project manager. When these are different companies, they are necessarily bound by a contract. When they are one and the same company, this practice is nonetheless recommended to ensure rigorous conduct of the project.

B6. In addition to my request A12, I would ask you to examine whether it is opportune to place an internal owner-project manager contract for the EDF personnel concerned.

3. Expansion of previous improvements to all DP2D projects

The stakes of the previous requests go beyond the case of the DIG and CHA2 projects and more globally concern the licensee's entire decommissioning project management organisation, but also the management of radioactive materials and wastes, spent fuels in particular. The inspectors checked whether DP2D considered and took advantage of the Excell¹⁷ plan being implemented by EDF.

B7. I would ask you to examine whether the generic improvements associated with the previous requests should be expanded to cover the other projects being developed by DP2D. I urge you to consider the work being done by EDF via the Excell plan, notably part 3 concerning the governance of large nuclear projects, in order to improve the coherent management of complex projects within the EDF group. You will inform me of any actions decided on accordingly.

¹⁷ In 2019, EDF launched the "Excell" plan which, for the nuclear industry, aims to achieve the highest level of rigour, quality and excellence.

C. Observations

ASN will be particularly attentive to the quality of the opportunity studies aiming to reduce the duration of the risk reduction steps, as set out in my request A21. These studies are decisive in producing the decommissioning schedule for BNI 153 on which the authorities will issue a position statement following review of the decommissioning file, which is to be submitted before the end of 2022. In order to reassure ASN that EDF is correctly addressing this matter, a technical meeting on the progress of these opportunity studies shall be proposed to ASN mid-way through the period preceding the above-mentioned deadlines, in order to demonstrate work to test the BNI 153 decommissioning schedules and the GCR reactors decommissioning programme that is commensurate with the stakes.

REFERENCES

- [1] ASN Resolution 2020-DC-0686 of 3 March 2020 prescribing submission of the decommissioning files for Chinon A1 and A2
- [2] ASN Chairman Resolution CODEP-CLG-2020-021253 of 3 March 2020, setting binding requirements concerning the preparation for decommissioning of reactors Chinon A1 and A2 and the next steps in the decommissioning of reactors Bugey 1, Chinon A3, Saint-Laurent A1 and A2
- [3] ASN Letter CODEP-STR-2020-004037 of 29 January 2020
- [4] ASN Letter CODEP-DRC-2020-021602 of 13 March 2020
- [5] ASN opinion 2020-AV-0357 of 6 August 2020 on the studies concerning the management of low level long-lived waste (LLW-LL), submitted pursuant to the National Radioactive Materials and Waste Management Plan 2016-2018, in preparation for the production of the 5th National Radioactive Materials and Waste Management Plan.