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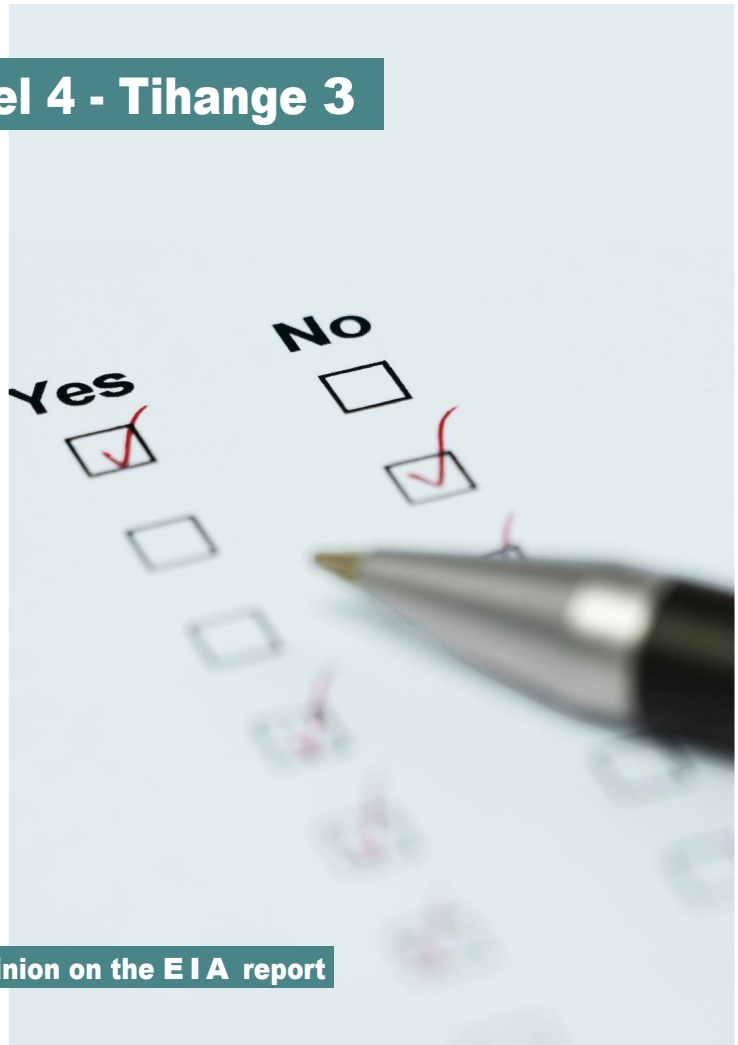
EIA Doel 4 - Tihange 3



Technical opinion on the E I A report

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UVP DOEL 4 - TIHANGE 3

Technical opinion on the EIA report

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SUMMARY

In view of recent energy challenges, the Belgian government has decided to extend the lifetime of the Doel 4 and Tihange 3 (D4T3) reactors by a period of ten years, starting with commissioning after 2025, following - as yet undecided - necessary modifications. This plan has not yet been agreed upon by all parties, nor are there any necessary legal changes that would allow such a lifetime extension. Nevertheless, an Environmental Impact Assessment (EIA) has been developed, since such an assessment is required by the applicable EU Directives as part of the licensing process for nuclear power plant lifetime extensions.

While the assessment of possible alternatives is very brief and not supported by a deeper analysis in the EIA report (it refers to a security of supply analysis conducted elsewhere), the conclusion that there could be a (much) higher risk to security of supply without the D4/T3 lifetime extension is correct. Nevertheless, such a brief assessment is not a substitute for a thorough analysis of the alternati- ves. The EIA report assumes that the modifications and upgrades will be implemented in- n approximately two years. It is quite possible that the period to restart D4/T3 will be longer. The discussion of alternatives offers no real consideration of how supply could be ensured in such a case.

The EIA report very briefly addresses the technical details of both units. This is particularly challenging considering that they are to be updated to the new FANC requirements (valid for nuclear power plants (NPPs) in operation in Belgium after 2025), as the Life Time Operation (LTO) program including Aging Management (AMP) still have to be developed and implemented. In addition, the FANC-requirement has also to be implemented, according to which the periodic safety reviews (PSRs) for both units have to be performed and all necessary safety verifications and modifications have to be implemented. In addition, the EU Commission's Communication on the Application of the Environmental Impact Assessment Directive [1] states that the EIA should reflect the status of the units after the Periodic Safety Review has been carried out and approved. This is currently not the case, as neither the PSR nor the LTO/AMP have been developed to date. This could be considered a deficiency since the "final" status of both units is unknown until PSR and AMP are developed. Therefore, the safety implications of any changes that might impact the analyses,

[1] (Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) on modifications and extensions of projects - Annex I.24 and Annex II.13(a), including the main concepts and principles related thereto (2021/C 486/01), reflecting the judgment of the European Court of Justice (ECJ) in connection with the Doel lifetime extension 1- 2.

which form the basis of the EIA cannot be estimated. Therefore, the present EIA report is not yet a basis for a final decision on the risks associated with an expansion of operations, especially from an Austrian perspective in a transboundary context.

The EIA provides information on the radioactive waste and spent nuclear fuel that will be generated at both sites. In general, the challenges associated with processing, siting, and disposal are domi- nated by the radioactive waste and spent nuclear fuel (RAW/SNF) generated in the past (i.e., through 2025) and are relatively minor affected by the proposed D4/T3 life extension.

With regard to radiological impacts on the environment as well as transboundary impacts, the EIA report evaluates the impact of three different accident sequences. These are assumed to be "limited" for both Design Basis (DBA) and Design Extension Condi- tions (DEC-B). The selection of two DBA and one DEC-B sequence for radiological impact is a prudent decision. However, the EIA does not provide information on the plant status under which these sequences were evaluated (e.g., current, with upgrades, with post-LTO and post-PSR plant status) or on the accident analyses themselves. Due to missing information on the considered design conditions of the plants as well as on the actual course and time of the accident sequences, an assessment regarding the plausibility of the presented results is not possible. In this context, the total amount of potentially released radioactivity is questioned.

Transboundary impacts are estimated for areas of approx.
200 x 350 km around Belgium calculated. The transboundary impact of a release from the Doel and Tihange sites could well affect areas up to 1000 km away, as has been estimated in other EIAs on nuclear power plant lifetime extensions. Furthermore, the transboundary effects are limited to the effects on the population, without estimation of the cesium deposition at larger distances, as also relevant for Austria, for example.

EXECUTIVE SUMMARY

In light of the recent challenges in the energy supply, the Government of Belgium decided to proceed with the lifetime extension of the reactors Doel 4 and Tihange 3 (D4T3) for a period of 10 years, counting from the start up post 2025 after necessary modifications - not yet decided - have been implemented. This plan has neither (yet) been agreed by all parties, nor are necessary legal changes that would allow for such a life extension in place. Nevertheless, an Environmental Impact Assessment (EIA) was developed because such is, under prevailing EU directives, required as a part of the process of approval of the life extension of nuclear power plants.

While the assessment of possible alternatives is very brief and is not supported by deeper analysis in the EIA report (it refers to analysis of security of supply done elsewhere), the conclusion is that without the lifetime extension of D4/T3, there is a (much) higher risk to the security of supply. Nevertheless, such a brief assessment does not substitute for a proper analysis of alternatives. The EIA re- port assumes that the modifications and upgrades would be implemented within about 2 years. It is as well possible that the period before restart of D4/T3 might take longer. The discussion of alternatives does not really offer any consideration as to how the supply would be assured if such happens.

The EIA report is very brief on the technical details of both units. This is challenging in particular considering that those are to be upgraded to the new FANC requirements (applicable for Nuclear Power Plants (NPPS) operating in Belgium beyond 2025), that the Life Time Operation (LTO) program including ageing management (AMP) still needs to be developed and implemented, as well as that there is the requirement by FANC that the Periodic Safety Review (PSR) for both units needs to be undertaken and any necessary safety upgrades and modifications have been implemented. Furthermore, the EU-Commission notice re- garding application of the Environmental Impact Assessment Directive 2, which reflects the European Court of Justice (ECJ) ruling in relation with the life exten- sion of Doel 1-2, specifies that the EIA shall reflect the status of the unit(s) following the performance and approval of the PSR, which, as neither the PSR nor LTO/AMP have been developed, cannot be the case. This could be seen as a de- ficiency because, as the PSR and AMP are not developed, the "final" status of both units is not known. Thus the safety impact of any modifications that might have an effect onto the analyses that are the basis for the EIA cannot be esti- mated. Therefore, the present EIA report is not yet a basis for making a final de- cision on the risks associated with an extension of operations, especially from an Austrian perspective in a transboundary context.

[2] Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) to modifications and extension of projects - Annex I.24 and Annex II.13(a), including main concepts and principles related to these (2021/C 486/01)

The EIA presents information on the radioactive waste and spent nuclear fuel that will be generated at each site. In general the challenges related to processing, storage and disposal are dominated by the historically (i.e. up to 2025) generated radioactive waste and spent nuclear fuels (RAW/SNF) and relatively marginally affected by the proposed lifetime extension of D4/T3.

In terms of the radiological impact onto the environment as well as the transboundary impact, the EIA assesses the impact stemming from 3 different accident sequences. It is believed that those are "bounding" for the Design Basis (DBA) as well as for the Design Extension Conditions (DEC-B). The selection of two DBA and one DEC-B sequences for the radiological impact is a prudent one. However, the EIA does not offer any information on neither the status of the plants under which those sequences were assessed (e.g. current, with some up- grades, with post LTO and post PSR status of the plants) nor the accident analyses themselves. Lacking any of the details on the plant design conditions con- sidered as well as on the actual progress and the timing of the accident sequences, it is not possible to assess the plausibility of the results achieved. Re- lated with this, the total amount of released radioactivity is questioned.

The transboundary impact is calculated for rectangular areas approximately 200 x 350 km around Belgium. The transboundary effect of a release from Doel and Tihange sites could in reality easily affect areas that are even 1000 km away, as it has been estimated in other EIAs for the lifetime extension of nuclear plants. Also the transboundary impact is limited to the effect on the population, missing the estimate of the Caesium deposition in far distances, e.g. as Austria is.

1 INTRODUCTION AND OVERVIEW

Since the mid-1970s, when the first Doel units came on line, Belgium has covered a large part of its electricity supply with nuclear energy, with its annual share of electricity supply ranging between 40 and 60 %. Over the years, strong opposition to nuclear power culminated in the passage of the January 2003 nuclear phase-out law by parliament, which called for the shutdown of nuclear power plants at the end of their planned 40-year lifespan. The law was amended several times, with one amendment allowing a 10-year extension of the life of Tihange 1 and another allowing a restart of Doel 1 (which was shut down under the original law) and continued operation of Doel 2 for 10 years.

In the meantime, Doel 3 was shut down in 2022 due to technical problems (carbon deposits in the reactor pressure vessel) and then Tihange 2 in 2023. Despite the CRM mechanism (Capacity Remuneration Me- chanism - market-wide capacity mechanism), unfavorable conditions on the EU electricity market made it clear that Belgium could face an energy shortage from the second half of the 2020s. To ensure supply, the government asked the Federal Agency for Nuclear Control (FANC) to examine the possibility of continuing to operate Unit 4 at the Doel site and Unit 3 at the Tihange site beyond 2025. In March 2022, under pressure from energy shortages and rising costs following the Russian inva- sion in Ukraine, the government decided to effectively extend the life of these two units by 10 years. This was accepted by the operator ENGIE. The plan is for the units to be shut down in 2025, refurbished and then operated for a period of 10 years from the date of first industrial electricity production after July 1 and September 1, 2025, for Doel 4 and Tihange 2, respectively.

As part of the preparation for the lifetime extension, the environmental impact assessment should be carried out, which also takes into account the transboundary impacts. In June 2022, Belgium notified Austria of the run- time extension as a proposed activity under the Espoo Convention and the Aarhus Convention. Austria is participating in the transboundary EIA process. ENCO, as consultant to the Federal Environmental Agency, reviewed the EIA report and elaborated comments and questions, which are listed b e l o w .

2 THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

The Environmental Impact Assessment Report for the ten-year extension of the operating lives of the Doel 4 and Tihange 3 nuclear power plant units was prepared based on the requirements of the Espoo Convention and the applicable EU Directives. The EIA report covers radiological and non-radiological impacts on the population and the environment, including water, air, climate, and human and non-human biota.

Radiological impacts have been assessed, focusing on national impacts in Belgium and on transboundary impacts of radiological releases during normal operation and in case of accidents. Also covered are the effects of radioactive waste as well as spent nuclear fuel generated during extended lifetime. Measures that would lead to a reduction in the impact of radiological releases, including emergency planning, are also covered.

3 PROCEDURE AND ALTERNATIVES

3.1 Summary of the expert statement

The EIA has been specifically developed to meet the legal requirements in the EU as laid down in the Espoo Convention, the EIA Directive and the Commission notice 3. The latter sets out the requirements for EIA in relation to nuclear power plant life extension. The latter sets out the requirements for EIA procedures in relation to nuclear power plant lifetime extensions. It should be noted that although the format and content of the EIA generally meets the requirements set out in the above-mentioned notice and the applicable directives, it appears somewhat out of context due to specific circumstances related to the life extension of the Doel 4 and Tihange 3 nuclear power plants. As defined in the EU legislation, the first step in the process of decision-making in connection with programs, directives or projects that could have transboundary impacts, in the development of the strategic environmental assessment. In this case, no such SEA was developed, but rather an EIA for the specific case of nuclear power plant lifetime extension. Nevertheless, the EIA contains a section discussing possible alternatives to the lifetime extension for Doel 4 and Tihange 3.

It is noted that the decision to extend the lifetime of these two nuclear power plants is primarily political and is seen as an expression of increasing uncertainty in the power supply in the second half of the 2020s and beyond. A few years ago, it was expected that, in addition to the increased use of renewable energy sources (solar and wind), the construction of new gas-fired power plants would fill the generation gap created by the closure of the Belgian nuclear power plants in 2025 (with a loss of 5.9 GW) and the decommissioning of older thermal units. In the meantime, and especially in view of the new situation of gas supply insecurity and price increase caused by the Russian invasion of Ukraine, the scenario that the gap would be filled mainly by gas-fired power plants, which would be called upon through the Capacity Remuneration Mechanism (CRM), is no longer considered realistic. Other alternatives, including the use of strategic reserves, import options from other EU countries, and increased development of renewables, are mentioned. The general conclusion, however, is that none of these options would be able to fill the gap left by the closure of such high produc- tion capacities.

[3] Commission notice regarding application of the Environmental Impact Assessment Directive (Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) to changes and extension of projects - Annex I.24 and Annex II.13(a), including main, concepts and principles related to these

While the assessment of possible alternatives is relatively brief and not supported by a more in-depth analysis of the EIA (the EIA report refers to several other studies and analyses of alternatives), the conclusion presented that without the extension of the operating life of Doel 4 and Tihange 3 there is a (much) higher risk to the security of supply can be accepted as quite plausible. Nevertheless, such a short analysis is not a substitute for a proper analysis of alternatives, which is required by EU legislation and has been carried out in other countries dealing with the extension of nuclear power plant lifetimes.

Although the situation of reduced availability and high gas prices due to the Russian invasion is (relatively) new, all other factors and conditions that would allow a thorough evaluation of alternatives were already present. Therefore, it is somewhat surprising that an evaluation of alternatives was not already undertaken at an appropriate time.

Another question related to the alternatives for extending the operating lives of Doel 4 and Thiange 3 concerns the period after 2025, when the units will be shut down, and until they are actually restarted in about two (or more) years. Current plans call for D4/T3 and Doel 1 and 2 to remain in operation until 2025, when D1/2 will be permanently shut down and D4/T3 will be closed for refurbishment, which is expected to take about two years. The "2-year period" might be considered somewhat optimistic (as discussed later), since the LTO (Long- Term Operation) -required activities, including the AMP (Aging Management Program) to be prepared and the 4th PSR (Periodic Safety Review), have to be carried out during this period. Once these are completed, all safety and other improvement activities must be completed, including those required to meet the new FANC requirements (for Class 1 nuclear facilities in operation after 2025). Therefore, it is quite possible that the time to restart D4/T3 could be even longer than 2 years. The discussion of alternatives does not offer any real consideration of how supply could be assured during that period.

The EIA report does not provide much information on the EIA procedure, in particular on how subsequent nuclear licensing procedures will have to be carried out in the course of the extension of the operating lives that is currently being sought. In subsequent nuclear licensing procedures, not only periodic safety inspections of both plants have to be carried out, but also an ageing management program. The resulting retrofitting requirements for both plants are to be defined and implemented subsequently. The links between the EIA procedure and the nuclear procedures would have to be presented in the EIA report.

The EIA report gives only a very superficial description of the two blocks. A more detailed description of the blocks in question, especially with regard to the differences between them, would have been appropriate.

3.2 Questions and preliminary recommendations

1) *Do the conditions imposed in the EIA procedure have a binding effect on the subsequent procedures, in particular the nuclear procedure?*

2) *In the unlikely event that D4/T3 are not restarted for an extended period of time (e.g., until 2029), what would be the impact of such a scenario on the power supply/security and stability of the grid in Bel- gium?*

3) *There are further nuclear power plant units at both sites that will be dismantled during the period of the planned LTE. What conditions laid down in the decisions apply to the plants being dismantled at both sites, against the background of the intended extension of operating life? Can it be ruled out, and if so how, that the dismantling of plants will not affect the intended lifetime extension of D4/T3?*

4) *In the absence of a firm agreement with the government, is it correct that a detailed plan for activities to support LTE for D4/T3 has not yet been developed? Since the list of required retrofits is not known at this time, it is difficult to determine the risks associated with a life extension or to assess the project in detail. Is it planned to carry out an EIA procedure again once the retrofits have been bindingly defined - in which the results of the required PSRs must also be included - so that the public concerned can assess the risks associated with an LTE?*

5) *A time chart describing the EIA process, the PSR pro- cess, the determination of safety improvements based on current safety requirements, and the timeline for implementation of necessary improvements would be welcome - all in the context of the proposed LTE and associated administrative procedures.*

4 SPENT FUEL AND RADIOACTIVE WASTE

4.1 Summary of the expert statement

The EIA document provides comprehensive information on the radioactive waste and spent nuclear fuel generated historically at each site. The quantities of RAW (Radioactive Waste) and SNF (Spent Nuclear Fuel) are presented both in absolute quantities and in quantities per unit of energy generated. This makes it relatively easy to predict how much waste will be generated over 10 years of extended operation.

Information on specific waste streams is provided, but at a very general level, without technical details. A description of the waste processing at the sites (including compaction and evaporation as well as cementation) and the transport of these wastes to NIRAS for further processing and storage/disposal is provided.

The Doel and Tihange sites generate short- and medium-lived radioactive waste (category A according to NIRAS classification) and small quantities of category B. The EIA report does not describe how much and how long RAW will be stored at each site before it will be transported for further processing at the Belgoprocess 4 company. Processing at the Belgoprocess site will focus primarily on volu- mization, e.g., for liquids with thermal or chemical processes, incineration at 900 degrees for combustible waste, and 2000-ton high-load compaction. The waste streams for which volume reduction is not possible are stored in drums.

Category A radioactive waste will be disposed of in a surface facility to be built in Dessel. The total capacity of the facility is 164,000 ^{m3} and consists of 34 modules. Current and projected radioactive waste generation until 2025 is estimated to occupy about 28.6 modules, which means that about 20% of the capacity is still available.

The 10-year life extension for Doel 4 unit is expected to generate (conservatively) about 460 $^{m3\ of}$ waste and about 405 ^{m3} for Tihange 3. These additional quantities of radioactive waste represent only about 5.7% and 5%, respectively, of the available spare capacity of the Dessel plant, which means that there is sufficient space to dispose of the waste expected to be generated by the longer operation of D4/T3.

[4] https://www.belgoprocess.be

At both sites, spent nuclear fuel (SNF) is stored on-site after discharge from the reactor, initially in the spent fuel pools. After the initial cooling phase, the SNF elements are transferred to the "dual purpose casks" (DPS), which are then stored on site either in the interim spent fuel storage facilities, the existing fuel container building (SGC) or the new ones, called SF2, which are expected to come on stream at the Tihange site in 2023 and at the Doel site in 2025.

For Doel 4, there are estimates that about 390 additional fuel assemblies will be generated (which will have to be stored) during the extended lifetime. For Tihange, there are no detailed statistics on the number of SNF elements generated, but it is estimated at about 42 per year or 420 for a ten-year extension. Compared to the total number of SNF elements discharged (without lifetime extension), this is only a 5% increase. The conclusion of the EIA is that such a small addition will not cause storage difficulties and that no new problems with additional SNF are expected due to the 10-year lifetime extension of D4/T3.

The decision on whether to reprocess SNF from Belgian facilities or to permanently dispose of SNF elements has apparently not yet been made.
Nevertheless, the concept of geological disposal in special "Su- percontainers" (described in detail in the EIA report) for disposal in clay layers, was developed as a result of decades of investigations at a facility in Mol in Belgium.

In general, the challenges associated with the processing, storage, and disposal of radioactive waste and SNF are dominated by the his- torically generated RAW/SNF and are relatively unaffected by the proposed lifetime extension of D4/T3.

4.2 Questions

6) *The EIA report states, "The permit application for the surface storage of category A waste in Dessel is in progress." What is the current status of the licensing procedures and the timetable for completion of the surface disposal site?*

7) *The EIA indicated that the Dessel facility will be limited "not only in volume but also in radiological capacity of the repository," with limits set for specific radionuclides. Please provide the limit values for the facility in terms of total activity and per radionuclide (for critical radionuclides only).*

8) *The projected radioactive waste generation does not appear to take into account any effects of the activities that will be required at D4/T3 to extend its operating life. It is known that there will be some specific LTE activities, but also specific activities related to safety improvements, including inspections, that could result in additional waste generation. Have you estimated how much additional waste could be generated in this process?*

9) *When will the decision regarding reprocessing or direct final disposal be made?*

10) *The EIA report states that "SNF will be stored underwater for at least 2 years." What is the average time that SNF is stored under water, i.e. in the SNF pool, at each site? What is the capacity of the individual pools at Doel 4, Tihange 3 and the common pool at Tihange?*

5 LONG-TERM OPERATION

5.1 Summary of the expert statement

The EIA was developed to assess the environmental impact of extending the life of the D4/T3 units over a 10-year period. While the EIA report covers a wide range of radiological and non-radiological impacts, as required by various Belgian, EU and international conventions, directives and standards, it contains very little information on the actual technical content, the technical description of the facilities under consideration and the technical content of the lifetime extension.

It is stated that new and stricter safety requirements of FANC must be met for the operation of nuclear power plants after 2025.
While the D4/T3 plants are the most modern plants in Belgium, the "delta" to the new FANC regulation in its design, and in particular through safety improvements implemented as a result of, for example, EU stress tests or WENRA directives, would be a long and resource-intensive process just for extending the life of a nuclear power plant, i.e., without the need to comply with new, more challenging regulatory requirements. The LTO, by international standard, requires the development, approval (by the regulatory authority), and then implementation of the Ageing Management Program. This is an extremely complex undertaking that is expected to take several years to prepare and implement. Furthermore, the final agreement between the operator ENGIE and the government is not yet available, which will define a schedule and, above all, provide technical information on the necessary activities of the operator and the authorities in the run-up to a restart of the D4/T3 units after 2025.

An aggravating issue appears to be the FANC requirement that PSR be performed prior to the launch of D4/T3 (and presumably at least some of the deliverables need to be clarified, which is likely to include the implementation of upgrades). This places an additional burden on the operator ENGIE to implement the PSR in parallel with the LTO/AMP. The EIA document does not provide any information on this. This could be seen as a shortcoming of the EIA, since PSR and AMP are not yet developed and the "final" status of both units is not known, including the safety impact of any changes that could affect the analyses performed, which form the basis for the EIA. In this respect, the available information from the EIA report does not allow a final assessment, as no information is presented on the relevant technical details, the technical modifications to the units and their evaluation.

5.2 Questions

11) *According to Belgian legislation, another PSR has to be carried out before the commissioning of the plants can be authorized. What is the planned schedule for the PRÜ? Has FANC already defined and/or approved the content of the required PSR?*

12) *Does Belgium intend to carry out analyses addressing problems of corrosive cracking of safety-related components as recently identified in French nuclear power plants? How is it ensured that the regulatory authority, on the basis of a timely available assessment of the PSR results and further analyses related to the intended LTO, will issue the necessary authorizations that would allow the intended start of the LTO to be met?*

13) *Will the Aging Management Program (AMP) be reviewed during its implementation (i.e., prior to commissioning of D4/T3 and after completion of the required measures), e.g., by IAEA SALTO?*

14) *It was reported that "Doel 4 and Tihange 3 largely meet the new FANC safety requirements that would apply after 2025, but a number of safety improvements are still required." Could you please provide a list of these safety improvements? Have these been considered in the analysis of the confining accident sequences for the EIA radiological impacts?*

15) *The EIA report does not include a description of the safety status of both plants, including the completion of the post-Fukushima safety improvements. Were all activities originally described in the NAcP for Belgium already implemented for Doel 4 and Tihange 3, or were there changes to the NAcP due to the fact that the units were scheduled to be shut down in 2025?*

16) *It was reported that several actions due from the 1st TPR "were not followed because the plants were scheduled to shut down in 2025." If D4/T3 do not extend their life, are these due? What are they and when are they to be implemented?*

17) *Given the difficulties in the availability of qua- lified nuclear personnel across the EU, how will the operator ensure the availability of resour- ces for*

a) necessary remediation measures at Doel 4 and Thiange 3, and

b) safe operation of the facilities for the period of 10 years thereafter?

6 UNFALLANALYSIS

6.1 Summary of the expert statement

Three different accident sequences are used in the EIA report to assess environmental impacts. Two of them are the Design Basis Accidents (DBA), the Loss of Coolant Accident (LOCA) event, and a Fuel Hand- ling Accident (FHA). These two are selected as the basis for meeting the requirement of Article 37 of the Euratom Treaty. In addition, a "comprehensive" severe accident was selected to assess the most critical human and environmental impacts.

The accident sequence selected was a Complete Station Black-Out Accident (CSBO), with the so-called DEC B (Design Extension Con- dition) consisting of a core meltdown and a release through the filtered containment vent (FCVS). For both the DBA and the DEC, accident analysis was recently performed by Tractebel in accordance with the FANC/Bel-V guidelines for accident analysis for Class 1 nuclear facilities.

The selection of two DBA accidents and one DEC-B accident is a prudent decision. The effects of these accident sequences are likely to be more or less comprehensive with respect to the impact on humans and the environment. The results obtained with respect to the amount of the various radionuclides released seem plausible, as does the impact assessment for the vicinity of the nuclear power plant sites

For the verification of these results, a comprehensible documentation of the performed accident analyses would be very desirable. The development of an accident scenario is strongly influenced by the assumptions made during the development and analysis of an accident sequence. However, such infor- mation is not available in the EIA report. In the case of the DEC-B sequence, the key role is played by the filtered venting system of the containment as well as assumptions about possible leaks from the containment, but also the time course of the accident. The EIA report does not elaborate on this. Each of these factors has a significant influence on the timing of the release and thus on the composition of the radio- nuclides released (source term) and thus on the effects on the environment and people.

6.2 Questions

18) *The DEC-B event (the CSBO sequence), which was used as the comprehensive sequence in the analysis of a radioactive material release, was not described in detail, so the description of the accident timing is missing, which is i m p o r t a n t because the Source Term is highly dependent on the actual timing of the release. Please describe the sequence of events in detail, including the timing and assumptions on which the analysis was based.*

19) *Within the CSBO accident sequence, especially depending on the triggering e v e n t , other SSCs in a plant may be affected, making it possible for an unfiltered release to occur simultaneously with a filtered release, e.g., due to contaminated intrusion or damage to an SG pipe.*

20) *The CSBO was selected as the most critical (comprehensive) accident to use as the baseline for estimating transboundary impacts. What plant status was considered in the analysis of this sequence, the current status of the plants or a future safety updated status? Please provide information in this regard.*

21) *Why is the CSBO sequence also a "comprehensive" event, even for the airplane crash, which by its nature (due to a jet fuel fire) is expected to have a very different impact on the facility than a CSBO event caused by extreme weather, for example?*

22) *The filtered venting system of the containment, which is one of the most important factors for limiting the effects of a release, is not described. The question is how effective it is for the retention of relevant radionuclides and how this effectiveness is proven (the EIA report states "it has a high effectiveness", but nothing more)?*

23) *What could be the source term of the most critical accident sequence in the event of a malfunction (e.g., bypass) of the filtered venting system?*

7 ACCIDENTS INVOLVING THIRD PARTIES

7.1 Summary of the expert statement

The EIA report does not elaborate on the accident caused by third parties. These are generally considered a separate "track" and treated as such - with appropriate confidentiality.

Nevertheless, it was published that a number of third-party hazards had been assessed, including terrorist attacks and an airplane crash, as well as cyber attacks, toxic and explosive gases, and blast waves. The results of the analysis had been incorporated into the National Action Plans (NAcP) for the stress tests and implemented in the NAcP.

7.2 Questions

24) *Can you confirm that all actions identified as necessary have been included in the NAcP and have now been fully implemented?*

8 CROSS-BORDER EFFECTS

8.1 Summary of the expert statement

In accordance with EU directives, the EIA report estimated the transboundary effects of a radiological release on both sites. In the case of Doel 4, which is located 3 km from the Dutch border, but also of Tihange, which is located 38 and 58 km from the Dutch and German borders, respectively, such analyses are important.

Transboundary impacts were assessed for normal operations (effluents) and for all three selected accident sequences, two DBA sequences LOCA and FHA, and for the DEC B sequence CSBO. As stated above, the EIA report does not provide information on the actual sequences or a complete source term of the accident.

Apart from the immediate neighborhood, cross-border impacts are calculated for rectangular areas of about 200 x 350 km around Belgium. This includes all of Belgium and Luxembourg, large parts of the Netherlands, and parts of France, Germany, and the United Kingdom. Dispersion was estimated using the Lagrangian particle model flex- part with actual historical numerical weather data from ECMWF for each hour in 2020. Time-integrated concentration (TIC) and integrated deposition estimates were produced.

As is well known and as can be seen from the radioactivity dispersion estimates e.g. in http://flexrisk.boku.ac.at/en/evaluationAg- gUnit.phtml#form, the transboundary effect of a release from the Doel and Tihange sites could indeed affect areas far beyond the rectangle assessed in the EIA. This is particularly true in the case of a large release (source term) that would
z. e.g. caused by a bypass or a malfunction of the FCVS. Such sequences could well affect areas as far away as 1000 km from the Doel and Tihange sites. While it is obvious that the impact would be smaller at greater distances (regardless of the initial source term), an estimate of the impact in a 1000 km circle, as has been done in other recent EIAs of nuclear power plant lifetime extensions in the EU, is important.

8.2 Questions

25) *The source term used in the dispersion modeling is not provided in the EIA report. Please provide the source term for the LOCA, the FHA, and for the envelope sequence (CSBO) in terms of*

a.) the release into the containment and

b.) the release into the environment.

an.

26) *For dispersion modeling, the methodology is to use the exact weather data for each hour in 2020, which means that a total of 8784 calculations were performed. It is not clear how the integration was performed to obtain the values for the 48-hour discharge, for example.*

27) *The impact assessment will be conducted for a period of 48 hours after the release (starting at the end of the release, which per se is expected to last 6 hours) and will be determined for the areas shown in Fig. 19. While this is obviously the most affected area, it is entirely possible that areas beyond Fig. 19, i.e., up to 1000 km, could be affected. Other recent EIAs on NPP life extension provided information on impacts in areas up to 1000 km from the source and included much more detail on estimated impacts, including deposition of e.g . C 137. Other similar EIAs also considered deposition over a longer period of time, for example.*

28) *Impairments as a result of severe accidents affect not only the population, but also the agricultural sector. In this respect, the depositions determined by analyses - also at a greater distance from the sites - would have to be considered with regard to the values applicable in neighboring countries, as well as in Austria. In Austria, for example, it is stipulated that environmental control measures are to be taken if the deposition exceeds 750 Bq, so that a negative impact above this deposition value is to be regarded as given.*

GLOSSARY

.....AMPAgeing Management Programs

.....CRMCapacity Remuneration Mechanism

.....CSBOComplete Station Black-Out

.....DBADesign Basis Accident

.....DEC-A/BDesign Extension Condition

.....DPSDual Purpose Casks

ECMWF .....European Centre for Medium-Range Weather Fore-casts

.....EUEuropean Union

.....FANCFederaal Agentschap voor Nucleaire Controle

.....FCVSFuel Containment Venting System

.....FHAFuel Handling Accident

GW .....Gigawatt

.....IAEAInternational Atomic Energy Agency

LOCA .....Loss of Coolant Accident

.....LTELifetime Extension

.....LTOLong Term Operation

NacP .....National Action Plan

NIRAS .....National Agency for Radioactive Waste

.....PSRPeriodic Safety Review

.....RAWRadioactive Waste

.....RLReference Level

.....SGSteam Generator

SGC .....Dry storage for spent fuel

.....SNFSpent Nuclear Fuel

.....SSCSystem Structures & Components

.....SUPrategic environmental assessment

TIC.....Time Integrated Concentration

.....TPRTopical Peer Review

EIA.....Environmental impact assessment

.....WENRAWestern European Nuclear Regulators' Association

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Answers to questions raised in the report by Umweltbundesambt GmbH, Austria

In the context of the cross-border consultation on the postponement of the deactivation of the Doel 4 and Tihange 3 nuclear power plants

On behalf of the Federal Public Service Economy, SMEs, Self-employed and Energy

Under reference 2022/77251/E2/EIE (Ref. SCK CEN: CO-90-22-6049-00)

Date: 28 July 2023

1 Introduction

This document answers the questions raised in the Technical Opinion Report on the Environmental Impact Assessment (EIA) on postponing the deactivation of the Doel 4 and Tihange 3 nuclear power plants introduced by the Umweltbundesambt GmbH, Austria in the context of the cross-border consultation on this EIA (report: Fachstellungnahme Umweltverträglichkeitserklärung).

This document follows the numbering of questions as provided in the report and is only available in English.

Information on the EIA on postponing the deactivation of the Doel 4 and Tihange 3 nuclear power plants, the EIA full reports, the non-technical summaries and the consultation process can be found via following links (different languages):

https://economie.fgov.be/nl/themas/energie/energiebronnen/kernenergie/openbare-raadpleging-over-de

https://economie.fgov.be/fr/themes/energie/sources-denergie/nucleaire/consultation-du-public-sur-la

https://economie.fgov.be/de/themen/energie/oeffentliche-konsultation-zur

https://economie.fgov.be/en/themes/energy/public-consultation-life

2 Answers to questions

Questions related to *Procedure and Alternatives* (Chapter 3)

1) Do the conditions imposed in the EIA procedure have a binding effect on the subsequent procedures, in particular the nuclear procedure?

As described in the Environmental Impact Assessment (EIA) report (Paragrpah 1.3. Procedure) the EIA is carried out within the framework of the European EIA Directive, the Habitats Directive and the Birds Directive. After the public consultation and the other consultations as described in the EIA report (including the cross-border consultation) a report with an analyses of the responses will be issued and a bill (a written suggestion for a new law) will be *submitted to the parliament. The EIA report includes some non-binding, both radiological and non-radiological, recommendations to further follow-up and/or further reduce the environmental impact.*

In addition to the EIA and fully related to the nuclear procedure, also the Long Term Operation (LTO) strategy has to be followed according to the legally binding process of the Periodic Safety Assessment. In this context we can add that on 29 June 2023, the federal government and ENGIE Electrabel concluded a concrete agreement on the extension of the operating period of nuclear reactors Doel 4 and Tihange 3. Subsequently, on 20 July 2023, the Belgian nuclear safety authorities (FANC) submitted its expectations regarding nuclear safety to ENGIE Electrabel. The detailed expectations can be found on the website of the nuclear safety authorities (FANC): https://fanc.fgov.be/nl/dossiers/kerncentrales-belgie/langetermijnuitbating-lto-van-doel-4-en-tihange-3-tot-2035. It is now up to ENGIE Electrabel to carry out the necessary preparatory studies and to submit them to the nuclear safety authorities (FANC) for approval, together with an extensive action plan. The necessary safety improvements may be spread over time and must all be implemented by 2028. The FANC will ensure that priority is given to the work most important for nuclear safety.

2) In the unlikely event that D4/T3 are not restarted for an extended period of time (e.g. until 2029), what would be the impact of such a scenario on the power supply/security and stability of the grid in Belgium?

The answer to this question in terms of security of power supply is to be found in § 1.2.2 and § 1.2.3 of the EIA, mainly based on the findings of the Adequacy and Flexibility Study 2022-2032, published by Elia (the operator of the Belgian electricity transmission network) in 2021. This study does not consider the extension of the operations of Doel 4 and Tihange 3 as a given, and thus provides an answer to the question what the impact would be if all Belgian nuclear power plants would be closed (at the latest) in 2025, in line with the original Law of January 31, 2003.

According to the 2021 Elia report, an additional flexible production capacity of about 3,6 GW would be needed after 2025 in order for the system to be able to comply with the requirements in terms of adequacy and flexibility; by 2032 the capacity need would probably have increased to 4,6 GW. Those figures are based on the so called 'EU-SAFE-scenario', which takes into account, among other developments, an increased unavailibility of the French nuclear fleet.

As stated in the report, developments in neighbouring countries mean that import of electricity alone (which would be needed in any case) could not be counted on to fill the gap. Instead, Elia estimated that, given a number of assumptions, implementation of the Capacity Remuneration Mechanism could provide the necessary generation capacity. In the longer term, growth in renewable energy capacity would provide additional power. The winters of 2025-2026 and 2026-2027 would however still be critical.

Evidently, a lot has happened since publication of the Adequacy and Flexibility Study 2022-2032 in 2021. The war in Ukraïne and the continued problems with the French nuclear fleet created an uncertain context in which the Belgian government would not rely solely on the CRM-mechnism and the development of renewables.

Very recently (in June 2023), Elia published its Adequacy and Flexibility Study 2024-2034. This study does consider the lifetime extension of Doel 4 and Tihange 3 as a given, and as such does not describe what would happen if this extension would not occur. The 2023 Elia study does however list the changes that occurred in both supply and demand (at EU and Belgian level) since the publication of the 2021 study. On the supply side, the additional capacity contracted through the CRM-mechanism, the increased offshore wind ambitions (but slower implementation) in the Belgian part of the North Sea and the development of new interconnectors (to the UK and Denmark) are mentioned. On the demand side, it is noted that the electrification of society happens faster and earlier than expected. The result is a considerably higher additional demand, that, according to Elia, could however be covered (given a number of assumptions and conditions) by the combination of nuclear generation, CRM, renawables and increased import capacity. It is obvious that, should nuclear (expected to be able to provide up to 27% of the increase in capacity needs) not be part of the equation, the task of filling this gap would have been notably more difficult.

We understand the question on the stability of the grid to be related to the way the electricity system can cope with variations in demand and generation. Among other things, the variability and uncertainty of renewable and distributed generation is a potential source of uncertainty that increases the need for balancing tools and measures. The Elia (2021) study confirms that flexibility needs will increase in th run-up to 2032, as a result of the integration of variable renewable capacity (mainly wind power) into the system. Periods of 'over generation' (to be managed by storage and export) are expected to be mitigated with the nuclear phase-out. The analysis shows that over the period 2022 to 2032, there will be sufficient capacity installed in the system to cover the identified flexibility needs. This is expected to be the case under every scenario and sensitivity where the installed capacity mix fulfils the adequacy needs of the system. In other words, the nuclear phase-out by 2025 would, as assessed by Elia in 2021, not result in unacceptable imbalances to the system.

3) There are further nuclear power plant units at both sites that will be dismantled during the period of the planned LTE. What conditions laid down in the decisions apply to the plants being dismantled at both sites, against the background of the intended extension of operating life? Can it be ruled out, and if so how, that the dismantling of plants will not affect the intended lifetime extension of D4/T3?

As decribed in the EIA report (§1.2.1.4), the decommissioning process includes different phases: during the post-operational phase (the phase directly after the final shutdown of a reactor for industrial generation of electricity) the operations are still covered by the exploitation license because they consist of activities, such as the removal of nuclear fuel and industrial waste and the flushing and emptying of pipes, which already take place during the operational phase of the reactor. This phase is currently estimated for the Doel 3 and Tihange 2 nuclear reactors to last for 5 to 6 years and no dismantling activities are foreseen in this phase (only preparation for dismantling). This phase will consequently have no impact on the Life Time Extension of Doel 4 and Tihange 3. The next phase is the real dismantling phase. For the dismantling of any nuclear buildings (reactors, …) a specific exploitation license has to be obtained and published as a Royal Decree. Also an Environmental Impact Assessment has to be executed for the dismantling activities. Because the processes of obtaining dismantling licenses and EIAs for dismantling have just started, specific conditions related to the dismantling of the units in final shutdown in context of the intended extension of Doel 4 and Tihange 3 are not yet known in detail. Some common nuclear infrastructure on both sites (e.g., the radioactive effluent processing facilities) is of course essential during the extended operation of Doel 4 and Tihange 3.

4) In the absence of a firm agreement with the government, is it correct that a detailed plan for activities to support LTE for D4/T3 has not yet been developed? Since the list of required retrofits is not known at this time, it is difficult to determine the risks associated with a life extension or to assess the project in detail. Is it planned to carry out an EIA procedure again once the retrofits have been bindingly defined - in which the results of the required PSRs must also be included - so that the public concerned can assess the risks associated with an LTE?

In the course of 2022, when negotiations between the operator of the nuclear power plants, Engie Electrabel, and the Belgian government had started, in parallel, discussions were held with the nuclear safety authorities on the potential design upgrades, modifications and projects to be performed in order to be compliant with evolving nuclear safety requirements applicable in Belgium. These discussions resulted in a detailed and exhaustive view on potential design upgrades and other potential projects. This set of potential design upgrades and other potential projects formed, together with other information, such as works to be performed in the non-nuclear part of the unit, the umbrella scope of works considered to be performed to prepare for another 10 years of operation. This umbrella scope of works, as described in the EIA in section 1.2.1.1 is to be regarded to be bounding with regards to environmental effects and risks. As mentioned in the answer to question 1), on 29 June 2023, the federal government and ENGIE Electrabel concluded a concrete agreement on the extension of the operating period of nuclear reactors Doel 4 and Tihange 3. Subsequently, on 20 July 2023, the nuclear safety authorities FANC submitted its expectations regarding nuclear safety to ENGIE Electrabel. The detailed expectations can be found on the website of the nuclear safety authorities (FANC): https://fanc.fgov.be/nl/dossiers/kerncentrales-belgie/langetermijnuitbating-lto-van-doel-4-en-tihange-3-tot-2035

5) A time chart describing the EIA process, the PSR process, the determination of safety improvements based on current safety requirements, and the timeline for implementation of necessary improvements would be welcome - all in the context of the proposed LTE and associated administrative procedures.

Timeline EIA and PSR.pptx

Attached timeline gives indicative planning in line with the requirements from FANC and Royal Decree on safety regulations for nuclear installations of 30 november 2021 (also called KBVVKI / ARPSIN) for implementation of the actions within a timeframe of anniversary date of the unit + 3 years.

Questions related to *Spent Fuel and Radioactive Waste* (Chapter 4)

6) The EIA report states, "The permit application for the surface storage of category A waste in Dessel is in progress." What is the current status of the licensing procedures and the timetable for completion of the surface disposal site?

The Minister decided on 23 April 2023 to grant the permit to construct and operate a surface disposal facility for low- and intermediate-level, short-lived waste at the Dessel site in Belgium. This decision was published as a Royal Decree in the Belgian Official Gazette on 16 May 2023.

All documents relating to the license application for a surface disposal facility for category A waste in Dessel, can be found on the website of the Belgian Nuclear Regulatory Body FANC:

https://fanc.fgov.be/nl/dossiers/vergunningsdossiers/afgeleverde-vergunningen/oppervlakteberging-dessel

Construction of the first modules is scheduled to start in 2024. The disposal facility is expected to be operational in 2027.

7) The EIA indicated that the Dessel facility will be limited "not only in volume but also in radiological capacity of the repository," with limits set for specific radionuclides. Please provide the limit values for the facility in terms of total activity and per radionuclide (for critical radionuclides only).

The category A waste inventory and the long-term safety assessment results allow to establish a preliminary source term for the Dessel near surface repository. The activity content of any critical radionuclide in the preliminary source term corresponds to this radionuclide's theoretical radiological capacity ('operational limit' or OLI) of the repository as a whole. In the license application, a range is proposed within which the theoretical OLI of a critical radionuclide may vary (§6.4.5.3 of chapter 6 of the Safety Report[1]). The lower limit of this range is 0, the upper limit is called the 'disposal limit' ('bergingslimiet' or BLI) and is set by applying a multiplication factor of 3 to the activity levels of the source term. This multiplication factor allows to take into account uncertainties on the radiological characteristics of the waste yet to be characterised and the future waste. The BLI's for the 28 critical radionuclides are listed in Table 1.

Modifying the OLI of one or several critical radionuclides within the proposed range (0 to BLI) constitutes a non-important amendment. Should ONDRAF/NIRAS wish to set the OLI higher than the current BLI for one or several critical radionuclides, this necessarily also sets a new BLI and constitutes an important amendment, i.e. an amendment of the license as such. In both cases, the evaluation criteria used for the various scenarios considered in the long-term safety assessment must be respected for the full set of OLI's.

[1] https://www.niras.be/hoofdstuk-6-uit-het-veiligheidsrapport-voor-de-oppervlaktebergingsinrichting-van-categorie-afval

Table 1: Disposal limits (BLI's) of the 28 critical radionuclides.

Radio-nuclide	BLI [Bq]	Radio-nuclide	BLI [Bq]
^{108m}Ag	6.90×10^{10}	^{237}Np	2.55×10^{9}
^{241}Am	1.63×10^{12}	^{238}Pu	9.57×10^{11}
^{243}Am	4.92×10^{10}	^{239}Pu	2.81×10^{11}
^{14}C	2.19×10^{13}	^{240}Pu	2.96×10^{11}
^{41}Ca	6.93×10^{12}	^{241}Pu	3.18×10^{13}
^{36}Cl	6.06×10^{10}	^{79}Se	2.70×10^{9}
^{244}Cm	5.70×10^{11}	^{126}Sn	3.75×10^{9}
^{135}Cs	1.12×10^{9}	^{90}Sr	9.57×10^{12}
^{137}Cs	2.42×10^{14}	^{99}Tc	2.24×10^{11}
^{129}I	4.23×10^{9}	^{234}U	2.31×10^{11}
^{93}Mo	6.09×10^{10}	^{235}U	1.13×10^{10}
^{94}Nb	1.20×10^{12}	^{236}U	1.74×10^{11}
^{59}Ni	1.50×10^{13}	^{238}U	6.63×10^{10}
^{63}Ni	1.63×10^{15}	^{93}Zr	4.89×10^{9}

8) The projected radioactive waste generation does not appear to take into account any effects of the activities that will be required at D4/T3 to extend its operating life. It is known that there will be some specific LTE activities, but also specific activities related to safety improvements, including inspections, that could result in additional waste generation. Have you estimated how much additional waste could be generated in this process?

Reference to section 4.3.3 of the EIA Doel 4/Tihange 3. The indicated amount of estimated additional waste due to the LTO is given as 460 m³. This takes into account the preparation works for the LTO, the LTO projects and the operational activities.

9) When will the decision regarding reprocessing or direct final disposal be made?

There is no policy yet regarding spent fuel management on the long term. The reference scenario currently considered by Synatom (spent fuel owner) and the waste management organisation ONDRAF/NIRAS is direct disposal of all the Belgian spent fuel. This scenario serves to determine the provisions that are needed to cover the long term management of the nuclear fuel, including final geological disposal.

10) The EIA report states that "SNF will be stored underwater for at least 2 years." What is the average time that SNF is stored under water, i.e. in the SNF pool, at each site? What is the capacity of the individual pools at Doel 4, Tihange 3 and the common pool at Tihange?

As the pools of Doel 4 and Tihange 3 are quite large, for these units the average cooling time is between 5 to 10 years under water storage in the pools of the units. The pools themselves have a total capacity of fuel assemblies equivalent to +/15 years of production.

Questions related to *Long-Term Operation* (Chapter 5)

11) According to Belgian legislation, another PSR has to be carried out before the commissioning of the plants can be authorized. What is the planned schedule for the PRÜ? Has FANC already defined and/or approved the content of the required PSR?

The LTO will be carried out as part of the 4th PSR, in line with the recommendations / requirements from the Safety Authority. As such the PSR LTO program has been built around several subprograms, including Ageing, Preconditions, Design, Test & Inspections, Knowledge Competence & Behaviour and PSR. The PSR subprogram will use the different outputs from the other subprograms as input for a comprehensive PSR review which will conclude in a PSR Summary Report to be submitted to the Safety Authority not later then 1st July 2025 for Doel 4 and 1st September 2025 for Tihange 3, in line with the Belgian regulations for Periodic Safety Reviews.

12) Does Belgium intend to carry out analyses addressing problems of corrosive cracking of safety-related components as recently identified in French nuclear power plants? How is it ensured that the regulatory authority, on the basis of a timely available assessment of the PSR results and further analyses related to the intended LTO, will issue the necessary authorizations that would allow the intended start of the LTO to be met? 13) Will the Aging Management Program (AMP) be reviewed during its implementation (i.e., prior to commissioning of D4/T3 and after completion of the required measures), e.g., by IAEA SALTO?

Electrabel follows the recent problems regarding cracking in the French nuclear powerplants closely. Actions have already been taken to analyse and investigate possible issues. The results of the performed analyses and inspections so far, lead to the conclusion that the Electrabel NPPs are not confronted with the same problems.

We continue to follow the EDF operating experience and complementary analyses. Further investigations or inspections may follow if new information becomes available.

The analyses and inspection results have been discussed at different stages with the Belgian authorities.

The Belgian NPPs have a "Living Ageing Management Program" that ensures effective ageing management of the Systems, Structures and Components (SSCs) throughout their entire service life.

Therefore, it relies on a systematic approach for coordinating the following plant programs relating to the understanding, control, monitoring and mitigation of ageing effects of the SSCs: Maintenance, Monitoring and Surveillance, In Service Inspections, Chemistry, Equipment Qualification and Obsolescence Management.

The scope and implementation of this ageing management program is yearly assessed by the Belgian Safety Authorities.

In preparation for the Long Term Operation of Doel 4 and Tihange 3 a specific detailed ageing analysis is performed, which is also being presented for approval to the Belgian Nuclear Authorities.

14) It was reported that "Doel 4 and Tihange 3 largely meet the new FANC safety requirements that would apply after 2025, but a number of safety improvements are still required." Could you please provide a list of these safety improvements? Have these been considered in the analysis of the confining accident sequences for the EIA radiological impacts?

See EIA section 1.2.1.1. for the list of design upgrades considered.

These design upgrades have not yet been taken into account for the radiological consequence studies; the studies have been done based on the current design.

15) The EIA report does not include a description of the safety status of both plants, including the completion of the post-Fukushima safety improvements. Were all activities originally described in the NAcP for Belgium already implemented for Doel 4 and Tihange 3, or were there changes to the NAcP due to the fact that the units were scheduled to be shut down in 2025?

All the actions in the NAcP (National Action Plan post Fukushima) have been performed for Doel 4 and Tihange 3. There were no actions of the NAcP removed because of the decision to stop the units in 2025 (decision end 2020) and The Belgian regulatory body (FANC and its technical support onrganisation Bel V) confirms the closure of the stress-tests action plan. See link : https://afcn.fgov.be/fr/system/files/best-2020.pdf and link : https://fanc.fgov.be/nl/dossiers/kerncentrales-belgie/nucleaire-stresstests/verslagen

16) It was reported that several actions due from the 1st TPR "were not followed because the plants were scheduled to shut down in 2025." If D4/T3 do not extend their life, are these due? What are they and when are they to be implemented?

On page 160 of the TPR report 2017 from FANC (https://fanc.fgov.be/nl/system/files/tpr-nar-belgium.pdf), it is indicated that :

"In the framework of this TPR, no additional action or improvement has been identified by the Safety Authority for the overall ageing management program. The Safety Authority considers that on this topic the ongoing action plans set up in the framework of the last PSRs (2012-2015) or of the LTO for the first units, in addition to the actions already performed in 2017 by the Licensee arising from its self-assessment in the frame of the TPR, are sufficient to achieve a complete ageing management program."

In case D4/T3 lifetime is not extended, no additional action is required.

In case D4/T3 lifetime is extended for 10 years starting from 2025, the systematic and comprehensive ageing management approach implemented in the units that already benefited from an LTO (that is to say Tihange 1 and Doel 1&2) will be implemented in Doel 4 and Tihange 3. Such extension of this ageing management program of Tihange 3 and Doel 4 will be implemented following the studies that will be performed for the anniversary date of these units in 2025.

17) Given the difficulties in the availability of qualified nuclear personnel across the EU, how will the operator ensure the availability of resources for a) necessary remediation measures at Doel 4 and Thiange 3, and b) safe operation of the facilities for the period of 10 years thereafter?

- *Competence management is within Electrabel's Nuclear Generation Management System a systemized process. A periodic multidisciplinary evaluation of the status of critical competences is being carried out and the necessary mitigating actions are being taken in order to ensure the availability of critical competences, keeping evolutions in the operating context into account.*
- *The topic 'Knowledge, Competence and Behavior' is a separate and complete chapter integrated in the PSR process for the life time extension of D4 and T3 and is challenged by the safety authorities. Focus is being put on a clear employability action plan in order to retain and retrain the competences of internal staff and further reinforcing the organization with new recruits.*
- *In the scenario of a life extension of T3 and D4, 5 reactors will be shut down in the period 2022 and 2025 (two have already been shut down). This means qualified staff becomes available and can be redeployed on the 2 reactors that have a life time extension.*

Questions related to *Accident Analysis* (Chapter 6)

18) The DEC-B event (the CSBO sequence), which was used as the comprehensive sequence in the analysis of a radioactive material release, was not described in detail, so the description of the accident timing is missing, which is important because the Source Term is highly dependent on the actual timing of the release. Please describe the sequence of events in detail, including the timing and assumptions on which the analysis was based.

The radioactive releases to the atmosphere associated with the CSBO accident scenario for Doel 4 and Tihange 3 are calculated using MELCOR (mass of group of radionuclides during the Severe Accident sequences) and ASTEC (mass of radionuclides linked to iodine behaviour during the severe accident sequences). Releases are calculated for 10 days and consist of two pathways: one continuous relaese originating from a containment leak rate and discontinous releases via the contaiment filtered venting system (CFVS) when pressure builds up in the containment (several ventings are considered in the 10-day release period). For the calculation of the cross border impact (referred to as the Flexpart methodology) the release quantities are summed and assumed to be released conservatevily in one single period of 6 hours.

19) Within the CSBO accident sequence, especially depending on the triggering event , other SSCs in a plant may be affected, making it possible for an unfiltered release to occur simultaneously with a filtered release, e.g., due to contaminated intrusion or damage to an SG pipe.

As mentioned in the answer to question 18, apart from releases through the Containment Filtered Venting System (CFVS) also a continuous release is assumed due to a containment design leak (release during the whole accident scenario). For completeness we can add that the use of the CFVS is mandatory according to the exploitation license of Doel 4 and Tihange 3.

20) The CSBO was selected as the most critical (comprehensive) accident to use as the baseline for estimating transboundary impacts. What plant status was considered in the analysis of this sequence, the current status of the plants or a future safety updated status? Please provide information in this regard.

Current status of the plant is considered. The future design upgrades have not been integrated in the calculations.

Future design upgrades will ensure that the current state of the plant will not degrade, on the contrary the objective of design upgrades is to improve the safety performance of the plant.

21) Why is the CSBO sequence also a "comprehensive" event, even for the airplane crash, which by its nature (due to a jet fuel fire) is expected to have a very different impact on the facility than a CSBO event caused by extreme weather, for example?

Safety systems (including containment) are designed to withstand the effect of the impact of an airplane crash, induced fire and vibration induced by the airplane crash.

At the commissioning of Tihange 3 and Doel 4, the following USNRC Regulatory Guides applied: R.G. 1.70.8, R.G. 1.70. It is mentioned in the Safety Analysis Report that the bunkered structures are designed to withstand an airplance crash and, therefore, if they were to occur, the integrity of the emergency systems and systems containing significant quantities of radioactive products would be maintained, as these systems are protected by the bunkered structures.

In conclusion, the "design basis" events are not likely to lead to unacceptable radiological consequences.

22) The filtered venting system of the containment, which is one of the most important factors for limiting the effects of a release, is not described. The question is how effective it is for the retention of relevant radionuclides and how this effectiveness is proven (the EIA report states "it has a high effectiveness", but nothing more)?

The filtered containment venting system features a filtering solution (scrubber) and different filtration stages. It allows to reduce the aerosols and iodine releases. Guaranteed minimum decontamination factor for aerosols is 10 000 and guaranteed minimum decontamination factor for iodine (molecular and organic) is 1000.

23) What could be the source term of the most critical accident sequence in the event of a malfunction (e.g., bypass) of the filtered venting system?

Malfunction of the filtered venting system is not considered as the system is qualified for severe accident conditions, for the use after an earthquake, is not impacted by flooding as sufficiently high, can be operated during a CSBO event thanks to batteries and manual actions, is qualified for extreme winds, lightning, rainfall and snowfall. Furthermore, operation of the CFVS can be done from the main control room, from the filter control room or locally.

Questions related to *Accidents Involving Third Parties* (Chapter 7)

24) Can you confirm that all actions identified as necessary have been included in the NAcP and have now been fully implemented?

Regarding the National Action plan post Fukushima (also called BEST action plan), all required actions have been performed for Doel 4 and Tihange 3.

Questions related to *Cross-Border Effects* (Chapter 8)

25) The source term used in the dispersion modeling is not provided in the EIA report. Please provide the source term for the LOCA, the FHA, and for the envelope sequence (CSBO) in terms of

a) the release into the containment and

b) the release into the environment.

As discussed in the EIA report, Article 37 is the original document that provides the source terms used for the initial dispersion modeling of the releases and which remains globally applicable. In this document, conservative source terms were considered for the FHA and the LOCA scenarios. Original radiological results obtained considering these source terms remain bounding for any other design base accidents and remain bounding of any more recent internal re-analyses due to the original strong conservatisms taken in the evaluation of the original radiological impact that were more easy to execute at that time.

Although these source terms were slightly increased following the Steam Generator (SG) replacement and the introduction of 18 month-cycles, it was verified that the reassessed radiological impact, using the same methodology but with more refined values for parameters such as the atmospheric dispersion coefficients, did not jeopardize the compliance with the Article 37 conclusions.

The LOCA, FHA and CSBO total source terms to the environment (most important radionuclide groups) can be found in the EIA report, in table 64 for Doel 4 and in table 99 for Tihange 3. Detailed source terms are calculated using MELCOR (mass of group of radionuclides during the Severe Accident sequences) and ASTEC (mass of radionuclides linked to iodine behaviour during the severe accident sequences).

26) For dispersion modeling, the methodology is to use the exact weather data for each hour in 2020, which means that a total of 8784 calculations were performed. It is not clear how the integration was performed to obtain the values for the 48-hour discharge, for example.

The methodology used for the assessment of the transboundary impact is described in the EIA report in section 2.3.4.3. Radioactive releases have been always (for all transboundary scenario's/calculations) conservatively limited to 6 hours or less, even for scenario's with release durations of for example 10 days. However, the radioactive releases (consisting of up to six release periods of one hour) are always followed (transport, dispersion and deposition of released quantities) for 48 hours, using the meteorological data (ECMWF) corresponding to this 48-hour period. The 48-hour corresponds consequently to the calculation period, not to the discharge or release period. In summary: for every hour of 2020 a one hour release is considered followed for 48 hours transport, dispersion and deposition (=8784 calculations). Based on this, for scenario's in which –always conservatively- a six hour release was assumed, six consecutive one hour periods (always followed for 48 hours) are aggregated into a total of 8779 six hour periods to assess maximum dose and deposition values (see footnote 30 in the EIA) in the neighboring countries.

27) The impact assessment will be conducted for a period of 48 hours after the release (starting at the end of the release, which per se is expected to last 6 hours) and will be determined for the areas shown in Fig. 19. While this is obviously the most affected area, it is entirely possible that areas beyond Fig. 19, i.e., up to 1000 km, could be affected. Other recent EIAs on NPP life extension provided information on impacts in areas up to 1000 km from the source and included much more detail on estimated impacts, including deposition of e.g. Cs 137. Other similar EIAs also considered deposition over a longer period of time, for example.

The calculations are performed using two grid resolutions (see detailed explanation EIA 2.3.4.3) corresponding to the two areas shown in Figure 19 (inner box around Belgium, and full domain of Figure 19). The larger domain spans a distance from both reactors depending on the direction from around 600 km up to 1000 km (see as example the plume in left part of figure 20). Indeed, the plume - diluted and depleted (due to deposition)- will be transported outside this domain. It is also possible that the plume has not reached the boundaries of the large calculation domain in the 48 hours the plume is followed or it re-enters the domain after 48 hours. To guarantee that in all situations every location within for example a 1000 km distance is fully covered, both the calculation area and time should be increased significantly having an important impact on the total calculation time (or the calculation resolution, number of calculations, …). For this reason we have opted to report very conservative (highest potential impact over more than 8000 simulations) dose and deposition values. In addition, we have limited in the EIA the results to the neighboring countries of Belgium. From the calculations performed, it is in principle possible to give also results for the other countries (or part of countries) in the large calculation domain (full area of Figure 19), but results in the neighboring countries of Belgium can serve as an (again conservative) estimate of dose values and deposition values in these countries. For example, the values reported for Germany or Luxembourg can be considered as conservative for Austria.

28) Impairments as a result of severe accidents affect not only the population, but also the agricultural sector. In this respect, the depositions determined by analyses - also at a greater distance from the sites - would have to be considered with regard to the values applicable in neighboring countries, as well as in Austria. In Austria, for example, it is stipulated that environmental control measures are to be taken if the deposition exceeds 750 Bq, so that a negative impact above this deposition value is to be regarded as given.

Deposition levels are calculated for every location in the full area of Figure 19 (so up to 600 to around 1000 km distance from Doel 4/Tihange 3 depending on the direction). As discussed in the answer to question 27) we conservatively opted for reporting results of the maximum values over more than 8000 simulations for the neighboring countries. For example, the deposition values reported for Germany or Luxembourg can be considered as conservative for Austria (see Table 65 for Doel 4 and Table 100 for Tihange 3).

The reference to 750 Bq in the question is not fully clear to us. As shown in Table 18 of the EIA different levels apply to the free trade of food and feed products in the EU, expressed in Bq/kg (750 Bq/kg is a value for strontium isotopes in general food products). Table 17 of the EIA gives derived levels for ground contamination in Bq/m^2 used in Belgian context in which countermeasures for the food chain are possible. If the 750 Bq refers to 750 Bq/m^2 ground contamination of certain specific radionuclides in Austrian context the values reported for Germany or Luxembourg in Bq/m^2 (Table 65 for Doel 4 and Table 100 for Tihange 3) can be used to very conservatively estimate the potential impact of the different accident scenarios.

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UVP Doel 4 – Tihange 3

Evaluation of Belgium answer to Austrian questions and clarifying questions

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Evaluation of Belgium answer to Austrian questions and clarifying questions

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CONTENTS

UVP D4 T3 EIA REVIEW

In the course of the evaluation, a total of 28 questions were raised in relation with 6 different areas of interest, from available alternatives for electric supply, over severe accidents to the transboundary impact. Although all of the questions were answered, not all answers were assessed as technically completed to the extent that a full understanding could be reached. The reviewer felt that in some of the answers the information provided was a repeat of what was already in the EIA report, which in the view of the reviewer was not sufficient or not sufficiently clear – which is why the question was asked in the first place.

The analysis as below is to document the evaluation of the answers received, with emphasis on the questions that should be discussed in more detail during proposed bilateral in-person consultations.

Question 1

Do the conditions imposed in the EIA procedure have a binding effect on the subsequent procedures, in particular the nuclear procedure?

Evaluation From the answer it does not seem that the EIA is binding in any way. Although this is mentioned in the answer ("*The EIA report includes some non-binding, both radiological and non-radiological, recommendations to further follow-up and/or further reduce the environmental impact*") no radiological-related recommendations for the follow-up have been identified in the EIA report. It is further unclear what is meant by the statement that the PSR is a "*legally binding process*". While the requirement to perform a PSR is legally binding, any findings are subject to discussion and ultimately agreement between the Regulator and Operator. It is also unclear whether the "FANC expectations" that are mentioned in the EIA and in some of the answers are legally binding in this framework, or just suggestions.

Question/discussion During bilateral in-person consultations, specific aspects of areas that are legally binding vs. those that are not are to be discussed. In particular when/if during the safety update process as well as the LTO activities there are solutions that would impact the results of the EIA, we would like to understand how those would be reflected in the EIA process.

Question 2

In the unlikely event that D4/T3 are not restarted for an extended period of time (e.g. until 2029), what would be the impact of such a scenario on the power supply/security and stability of the grid in Belgium?

Evaluation The answer does not really provide any further information as to what would be projected effects in the supply of electricity in the case that D4T3 startup would

be delayed. The references to previous studies are not providing any clarity, because as it is indicated in the answer the framework conditions have changed in terms of availability of replacement power but also the unitisation profile.

Question/discussion During bilateral in-person consultations, it would be very useful to have a full understanding of the plan to bring the D4T3 units back in operation and possible challenges that might delay the implementation of those plans.

Question 3

Question answered

Question 4

In the absence of a firm agreement with the government, is it correct that a detailed plan for activities to support LTE for D4/T3 has not yet been developed? Since the list of required retrofits is not known at this time, it is difficult to determine the risks associated with a life extension or to assess the project in detail. Is it planned to carry out an EIA procedure again once the retrofits have been bindingly defined - in which the results of the required PSRs must also be included - so that the public concerned can assess the risks associated with an LTE?

Evaluation The answer claims that the EIA developed on the basis of current knowledge/ status is an “enveloping” assessment of the potential impact of D4T3 life extension. It is stated that a there will be extensive safety upgrades (at least that is what FANC expects; though an answer to a question later-on suggests that there might not be that many safety upgrades needed) Still, even with all LTO measures, the ageing-caused degradation during the remaining 10 years of operation is likely to reduce safety level. This does not seem to have been taken into account in the analysis, in particular that the LTO degradation might be affecting some specific items or SSCs that might be disproportionally relevant for the overall safety level. From the reply to Question 2, it looks that there will be no update of the EIA, and therefore it is not clear where the potential impact of possible LTO related degradation would be assessed.

Question/discussion During bilateral in-person consultations, it would be good to be able to discuss the timeline of all the activities planned, depicting safety upgrades and eventual LTO degradations. The Austrian side would like to know what the safety level achieved at the planned end of life (i.e., 2037) would be, considering safety measures as well as ageing related degradations.

Question 5

A time chart describing the EIA process, the PSR process, the determination of safety improvements based on current safety requirements, and the timeline for implementation of necessary improvements would be welcome - all in the context of the proposed LTE and associated administrative procedures.

Evaluation The time chart is indicated as "integrated" but it was not attached. From the written answer it appears that it is expected that the implementation of all activities would be completed in 3 years' time. While it is known that Engie has been making studies and other preparation, it is not clear whether the supply chain issues, labour issues, etc. would allow for the plan to be adhered to.

Question/discussion During bilateral in-person consultations, the time schedule that was mentioned in the answer is to be provided. Also, the discussion on possible effects of e.g., supply or labour shortage on the plants would need to be explained.

Question 6

Question answered

Question7

Question answered

Question 8

Question answered

Question 9

Question answered

Question 10

Question answered

Question 11

According to Belgian legislation, another PSR has to be carried out before the commissioning of the plants can be authorized. What is the planned schedule for the PSR? Has FANC already defined and/or approved the content of the required PSR?

Evaluation The question has been answered as far as the schedule is concerned, but not regarding the content of the PSR. The content of a PSR is expected to be defined in the Belgian regulation. In accordance with the explanation in the EIA, some "subprogrammes" e.g., for the "LTO PSR" are expected to be added. From the answer one could conclude that the whole LTO would be (in terms of licensing) handled as a part of the PSR, which is also the case in some other countries.

Question/discussion During bilateral in-person consultations, we would like to obtain the clarifications as to actual content of the PRS to be undertaken at D4T3 units, considering the mandatory requirement for a PSR as well as any add-ons. Also, a clarification whether the license for extended operation would be issued on the basis of the PSR (to include ageing) or the two processes would be treated separately.

Question 12

Question answered

Question 13

Will the Aging Management Program (AMP) be reviewed during its implementation (i.e., prior to commissioning of D4/T3 and after completion of the required measures), e.g., by IAEA SALTO?

Evaluation The part of the question regarding the SALTO mission has not been answered. The IAEA calendar does not indicate any planned missions to Belgium, though if the planned start-up post-LTO is planned for 2027 there is still time for such.

Question/discussion During bilateral in-person consultations we would like to know whether D4T3 will be subject to an IAEA SALTO review

Question 14

It was reported that "Doel 4 and Tihange 3 largely meet the new FANC safety requirements that would apply after 2025, but a number of safety improvements are still required." Could you please provide a list of these safety improvements? Have these been considered in the analysis of the confining accident sequences for the EIA radiological impacts?

Evaluation The answer recalls the section 1.2.1.1 of the EIA, where the list of "design improvements" 3 items: improvement to cope with increased temperatures in the environment, a new emergency centre and better cooling of the SNF pools. It is a bit hard to believe that apart from those 3 no other safety improvements would be needed in accordance with FANC's post 2025 guidelines (which, in our understanding, was developed to apply to new reactors).

Question/discussion During bilateral in-person consultations we would appreciate obtaining information to understand how come that with only those 3 safety measures D4T3 would be able to comply with FANC requirements for the operation post 2025.

Question 15

Question answered

Question 16

It was reported that several actions due from the 1st TPR "were not followed because the plants were scheduled to shut down in 2025." If D4/T3 do not extend their life, are these due? What are they and when are they to be implemented?

Evaluation This question was raised because there was an official statement in the Belgian TPR status report in this respect. The answer however does not indicate which those actions might be, but rather stated that there are no outstanding questions. It also makes reference to the PSR 2012 as well as the LTO for the units D1/2T1 from 2017, which is before the 1st PSR, so it is not clear what is the relevance of this. The answer also indicates is that the LTO for D4T3 will be "comprehensive". In our view none of this answers the question.

Question/discussion During bilateral in-person consultations we would like to know which actions were meant in the official Belgian statement on the NAcP for the 1st TPR as "not followed", and whether those are to be implemented now as part of the LTO improvements?

Question 17

Question answered

Question18

The DEC-B event (the CSBO sequence), which was used as the comprehensive sequence in the analysis of a radioactive material release, was not described in detail, so the description of the accident timing is missing, which is important

because the Source Term is highly dependent on the actual timing of the release. Please describe the sequence of events in detail, including the timing and assumptions on which the analysis was based.

Evaluation The answer indicated that MECOR and STEC codes were used. The question on the description of the sequence was not answered, so we do not have any indication as to what is actually considered to have happened, what would be the timing of the sequence, important assumptions, etc. all of which would be relevant for the source term. The fact that the release from a leaking containment (expected to be estimated at a full containment design pressure) and by releasing via the filtered vent over a period of 10 days is an important additional information. Also that the total release is added up and summarised in a period of 6 hours for the transboundary impact is an important new information (clarification; it is in the EIA report but described in the way that it was not understandable).

Question/discussion During bilateral in-person consultations we would like to obtain (much) more details in relation to the exact accident sequence, relevant assumptions, conditions, timing of various important steps/development, etc.

Question 19

Within the CSBO accident sequence, especially depending on the triggering event, other SSCs in a plant may be affected, making it possible for an unfiltered release to occur simultaneously with a filtered release, e.g., due to contaminated intrusion or damage to an SG pipe.

Evaluation The question was not answered, as the details of the sequence, timing and assumptions were not made available. The fact of the matter is that, depending on the assumption, the CSBO sequence that was used to determine the source term might not be the most conservative one, and thus underestimating the off-site consequences.

Question/discussion During bilateral in-person consultations we would like to obtain deeper understanding in relation to the sequence analysed as well as to why this sequence was assessed as being the most conservative (in terms of the release) to be the enveloping one for all other releases. Also, we would like to see the justification as to why any other possible releases (e.g., SG tube, leaking or failed containment penetrations), especially in the view of the LTO) were excluded as less likely or less important.

Question 20

Question answered

Question 21

Question answered

Question 22

Question answered

Question 23

Question answered

Question 24

Question answered

Question 25

The source term used in the dispersion modelling is not provided in the EIA report. Please provide the source term for the LOCA, the FHA, and for the envelope sequence (CSBO) in terms of

a. the release into the containment and
b. the release into the environment.

Evaluation The complete source term was not provided, neither for the release into the containment nor the release outside of the containment. A reference is made to the tables 64 and 99 in the EIA report that provided the "source terms to the environment (most importantly radionuclides)" for Doel 4 and Tihange 3, respectively. The source terms for the LOCA and for the fuel handling accidents are those that have been submitted for the EC assessment within Article 37 of Euratom (in 1981) and the source term for the severe accident DEC B comes from the analysis of the sequences Complete station blackout (CSBO) that leads to a core melt and release by leakage from the containment and through the containment filtered vent system releases.

The question was not really answered as the source term into the containment was not provided (which is relevant for the assumption of the retention function of the containment). The source term to the environment was provided for "most important radionuclide groups", which is not what is typically provided in other recent EIAs. What is also obvious from the EIA and confirmed in the answer, the analyses have been done some time ago (2014) apparently in the scope of the PSR or post-Fukushima stress test and not repeated for the EIA.

Question/discussion During bilateral in-person consultations we would like to obtain further details on the a) source term of all radionuclides that are being released in the containment and b) into the environment.

Question 26

Question answered

Question 27

The impact assessment will be conducted for a period of 48 hours after the release (starting at the end of the release, which per se is expected to last 6 hours) and will be determined for the areas shown in Fig. 19. While this is obviously the most affected area, it is entirely possible that areas beyond Fig. 19, i.e., up to 1000 km, could be affected. Other recent EIAs on NPP life extension provided information on impacts in areas up to 1000 km from the source and included much more detail on estimated impacts, including deposition of e.g. Cs 137. Other similar EIAs also considered deposition over a longer period of time, for example.

Evaluation The way the EIA is presented it was unclear that the larger "area" in the Fig 19 is the area for which the radiological impact has been calculated. Nevertheless, by deciding to provide only an example for each plant (Fig. 20 and 21) as well as examples of impact (from Doel to France for noble gases; deposition of Cs in Germany), the estimate of an actual impact to e.g., Austria cannot be concluded. In the answer, it is said that the impact of the deposition to Austria could be read from the values for Luxembourg and Germany. This however is not really the case as we have seen from the actual releases of e.g., Chernobyl, where some much more distant areas have been more heavily affected than areas closer by. This in particular might apply to Austria, because due to the prevailing western weather direction, it is the Alps that tend to get more of the rain and with that the deposition from a releases that are coming from north westerly direction. Therefore, estimating the impact of the deposition on Austrian territory from values provided for Luxembourg or Germany is not believed to be leading to correct results.

A chart depicting a total deposition across the areas as depicted in Fig 19 would be highly useful.

Question/discussion During bilateral in-person consultations we would like to obtain further details, in particular access to the chart(s) depicting radiological impact that are indicated to have been prepared for all the geographical area that is indicated in Figure 19 of the EIA.

Question 28

Impairments as a result of severe accidents affect not only the population, but also the agricultural sector. In this respect, the depositions determined by analyses - also at a greater distance from the sites - would have to be considered with regard to the values applicable in neighbouring countries, as well as in Austria. In Austria, for example, it is stipulated that environmental control measures are to be taken if the deposition exceeds **750 Bq/m²**, so that a negative impact above this deposition value is to be regarded as given.

Evaluation

The "750 Bq" in question 28 is obviously 750 Bq/m² for the "deposition value " of Cs 137 (as it was clearly indicated in the question). This value coincides with the trigger for the initial countermeasures (monitoring) in Austria. As indicated in the answer to question 28, the EIA opted for reporting results of the maximum value from the simulation in each country. Such a representation is really not saying much, because only a maximum is reported, but there might be many places where the values might be close to the maximum, which from a single data point per county (this maximum) cannot be seen/understood. Much better reporting is to have a map indicating the values, as some recent EIAs did.

In terms of estimating the ground contamination for Austria, a maximum (single spot) ground deposit in Germany of 5000 Bq/m² and in Luxembourg of 2430 Bq/m² make it impossible to conclude that there would be no place in Austria having ground deposits in excess of 750 Bq/m².

Question/discussion

During bilateral in-person consultations we would like to obtain further details on the profile of the deposition for all areas as depicted in Figure 19, and in particular for the pre-Alpine and Alpine areas in Austria.

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Consultation with Austrian authorities

Environmental impact assessment on 10-year extension of Doel 4 – Tihange 3

Dr Ir Alberto Fernandez Fernandez

Director Nuclear Applications
Directorate-General for Energy

Question 1

Do the conditions imposed in the EIA procedure have a binding effect on the subsequent procedures, in particular the nuclear procedure?

Context of the decision

When the present government entered in charge in 2020, it was agreed that a final assessment of the feasibility of the phasing out of all nuclear reactors under the existing calendar would be undertaken in the spring 2022,

18 March 2022

Taking into account the problems of electricity supply from neighboring countries, the high dependence on fossil fuels, the accelerated energy transition, the geopolitical tensions that makes prices very volatile and puts the supply of natural gas under pressure, the Belgian government took the decision, on March 2022, to prepare for the Parliament an amendment to the law of 31 January 2003 in order to allow the LTO of the two most recent reactors.

1 April 2022

Government agreed on a project of draft law to allow the operation of the nuclear reactors of Doel 4 and Tihange 3 for another 10 years.

This draft law is to be finalized after carrying out an environmental impact assessment of the LTO and the necessary safety-related works for this extension including a public consultation, a consultation of the relevant national authorities and transboundary consultations in accordance with the Espoo Convention.

Legal basis

- The environment is mainly a regionalized matter in Belgium
- Specific transpositions have been made for **Federal** competences, notably for the marine environment and for protection against ionizing radiation.
- The legal basis for the environmental impact assessment can be found in the following European directives (as interpreted by the Court of Justice of the European Union in the case C-411/17 and the Belgian Constitutional Court in the judgement nr. 34/2020 with regard to the extension of Doel12)
    1. Directive 2011/92/EU of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment on the environment (EIA Directive),
    2. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (hereinafter Habitats Directive),
    3. Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds (the Birds Directive).

Legal basis

Based on these directives, prior to the adoption of a new law, an environmental impact assessment and an appropriate evaluation should be carried out, including, in substance:

- The drafting of an EIA describing, in particular, the "project", its significant impacts on the environment, including on sites protected by the "Habitats" Directive, the justification of the project with regard to its potential impacts on the environment, the measures already taken by the nuclear operator to remedy these impacts and the alternative solutions envisaged, as well as the reasons why they were not chosen.
- Consultation on the project and the EIA with Belgian authorities likely to be affected by the project, because of their specific competences in environmental matters or their local or regional competences
- Consultation on the project and the EIA of the "public concerned" by this "project".
- Consultation on the project and the EIA of the States parties to the Espoo Convention within a radius of 1000 km (= good international practice) around the nuclear sites of Doel and Tihange, as being likely to be affected by the "project" (including in the event of a serious accident), provided that these States have declared their interest in participating in the assessment process.
- The "consideration" of elements 1 to 4 in a motivated conclusion that is an integral part of the future law

Belgium decided to carry out the environmental impact assessment of the 10-year extension of the operation of Doel 4 and Tihange as soon as it was possible

- Belgium decided to carry out the environmental impact assessment of the 10-year extension of the operation of Doel 4 and Tihange as soon as it was possible to identify and assess all potential significant adverse impacts that the proposed activity is likely to have on the environment and engage in national and international public consultations.
- The final list of works to be carried out was not yet available. Therefore, the environmental impact assessment is based on information on the works available on 31 January 2023 (see EIA report)
- Belgian regulations also require that all modifications to nuclear installations are being evaluated to determine whether a modification of the nuclear license is necessary and if a subsequent EIA is required in the future.

List of works as known on 31 January 2023

- Works taken into consideration in the EIA :
  - Design improvements : the key design improvements identified as "needs" or requirements are as follows :
    - Management of extreme temperatures
    - Strengthen emergency planning centers
    - Robustness of the cooling of the irradiated nuclear fuel docks
  - Ageing management : the requirement for all safety-related systems, structures and components is to demonstrate that their qualification remains valid in the new operation period. For the major mechanical components (reactor vessel, reactor cover, steam generators), the safety authority estimates, based on the information available on 31 January 2023, that they do not need to be replaced. For other components, there is currently no complete picture of possible replacement works.
- The non-radiological impact of these works is very localized and generally limited to the site No radiological impact for the works as such are expected. The production of radioactive waste is assessed for both the LTO operation and the safety-related wworks.

Planning as of 13/11/2023

1 Apr 2022	Approval of the draft bill amending the law of 31 January 2003	✓
Jun 2022	Notification of national competent authorities	✓
	Notification of international competent authorities within 1000 km radius	✓
1 Sep 2022 – 31 Jan 2023	Realization of the EIA report by SCK CEN (with specialized experts with the required legal accreditation)	✓
1 Mar 2023 – 20 Jun 2023	National consultation	✓
1 Mar 2023 – 20 Jun 2023	Transboundary consultations with border countries (except Austria)	✓
1 Mar 2023 – 30 Nov 2023	**Transboundary consultation with Austria - Official meeting : 13/11**	
30 Nov 2023 – 31 Dec 2023	Approval of the final draft bill of the law, consultation RvS-CdE in urgency,…	
1 jan 2024 – 31 Jan 2024	Vote of the law in Parliament	

Question 2

If Doel 4/Tihange 3 are not restarted, what would be its impact on the SoS of electricity in Belgium?

The 10-year extension of Doel 4 and Tihange 3 units are critical for guaranteeing the security of supply of electricity in Belgium

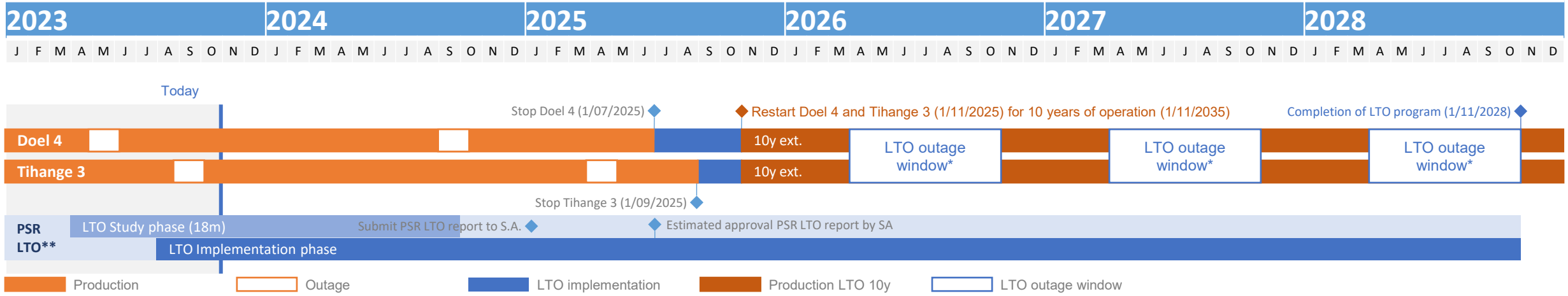
- The recent approved T-4 auctions for our CRM considered the availability of these units in Nov 2025 (2077 MW).
- All scenarios for the CRM auctions are systematically submitted to public consultation by the TSO ELIA. The energy regulator CREG makes a proposal to the government. The government take the final decision after taking into consideration the results of the consultation, the proposal of the regulator and the opinion of the Federal administration competent for energy.
- Any delay in starting the operation of these units may impact very seriously the SoS situation in Belgium as this would require finding 2 GW capacity in the market in a very short period. The Belgian authorities are convinced that a T-1 auction will not be appropriate to capture this missing volume in such a short period.

https://economie.fgov.be/fr/themes/energie/securite-dapprovisionnement/electricite/mecanismes-de-capacite/mecanisme-de-remuneration-de/encheres-dans-le-cadre-du-crm
https://www.elia.be/fr/consultations-publiques/20230418_public-consultation-on-the-scenarios-sensitivities-and-data-for-the-crm
https://www.elia.be/-/media/project/elia/elia-site/public-consultations/2023/20230418_crm_explanatory_note_dy2025_y_1dy2028_y-4_auction_en.pdf

Question 4

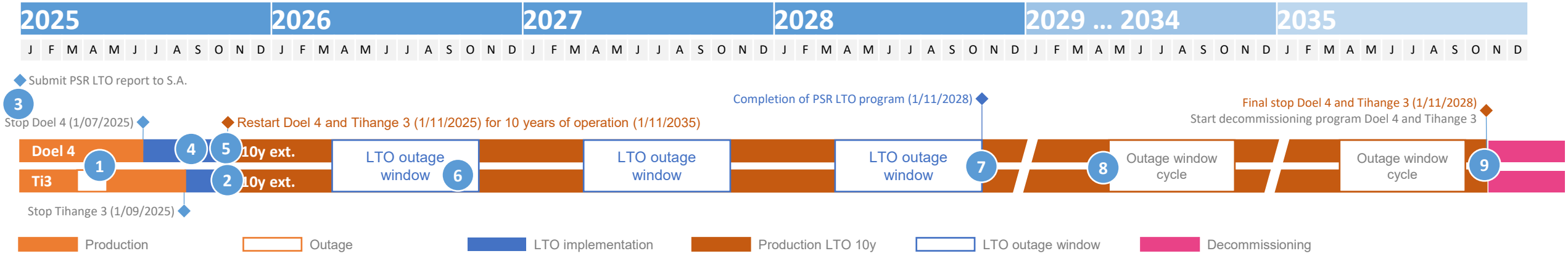
Timeline of all the activities planned, depicting safety upgrades and eventual LTO degradations

LTO programme Doel 4 and Tihange 3 (2023-2028)



* LTO Outage windows = maximum timeframes outside winter months in which extended outages are possible to perform LTO activities after restart, to be implemented at the latest 3 years after start 10 year period (1/11/2028), as agreed with the safety authorities. Exact duration to be defined at a later stage.

** The PSR LTO project (Periodic Safety Review – Long Term Operation) runs until 1/11/2028, deadline for implementation of all PSR LTO activities as agreed with the safety authorities. The units can start production from 1/11/2025 when all safety related PSR LTO activities have been completed. Other works will be done during extended outages outside of the winter periods.



1. On 1 July 2025 Doel 4 will be shut down after 40 years of operation. Tihange 3 will follow 2 months later. For Doel 4, the last regular outage will take place around September 2024 and for Tihange 3 in April 2025.

2. ENGIE has agreed with the Belgian government that it will do its reasonable efforts to restart both Doel 4 and Tihange 3 on 1 November 2025 for an additional 10 years of operation. This means there is a window of 2 to 4 months to have the units ready and approved by the safety authorities.

3. Our power plants have always undergone a periodic safety review (PSR) every 10 years. Hence, after 40 years of operation, a new (4th) PSR needs to be prepared and approved by the safety authorities before the units can be put back in operation. The PSR report has to prove that our units and our organization are prepared for another 10 years of operation.

4. Once the safety authorities agree with our periodic safety report (target date 1 July 2025), we can start with the implementation of all the actions we have outlined in the PSR: the Global Action List (GAL). However, due to the challenging window between the stop of the units and the planned restart, we have already started with the preparation of the implementation by ordering some parts, contacting suppliers and ensuring external companies will have resources available to assist in the implementation of the PSR related works.

5. The safety authorities will give green light to restart our units once a predefined list of activities has been completed.

6. Other works may be performed after restart as long as everything is finished within 3 years after restart. Derogations are only possible if formal approval by safety authorities. This gives us 5 years to complete the entire LTO program, from the start of the study phase in 2023 until the last works in 2028. A further constraint is that we have agreed with the Belgian government to have both units operational during winter months.

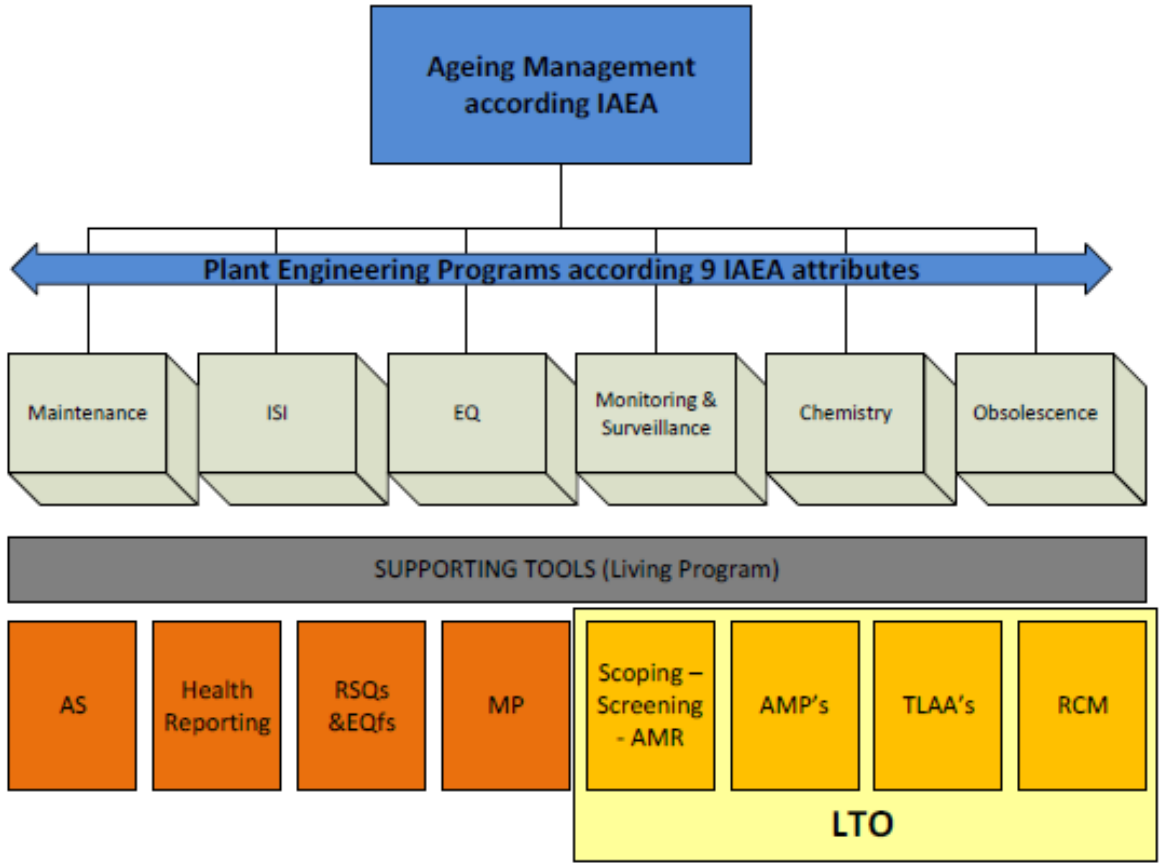
7. The implementation will take about 5 years with a peak of activities during planned extended outages outside winter periods. The LTO implementation, and by extension the entire PSR LTO programme, will end with the last action on the Global Action List (GAL) completed.

8. From 2029 onwards, the units will operate in a flexible fuel cycle which will allow for outages outside the winter months of about 1 month for each unit, one after the other.

9. Finally, after 50 years of operation, Doel 4 and Tihange 3 will be shut down and enter the decommissioning phase.

Ageing degradation

- An active living ageing management program is implemented on both sites to monitor the state of the SSC's throughout their lifetime. (the brown blocks left bottom) – as required by the Belgian Regulatory Framework).
- As part of LTO the lower right blocks are performed in the LTO studies as complement to the existing living ageing management program.
- Both elements together enable the process of ageing management for SSC's and to ensure the SSC's will continue to perform their intended
- On the other hand, the design upgrades (and other PSR actions) should increase the safety levels during the LTO.

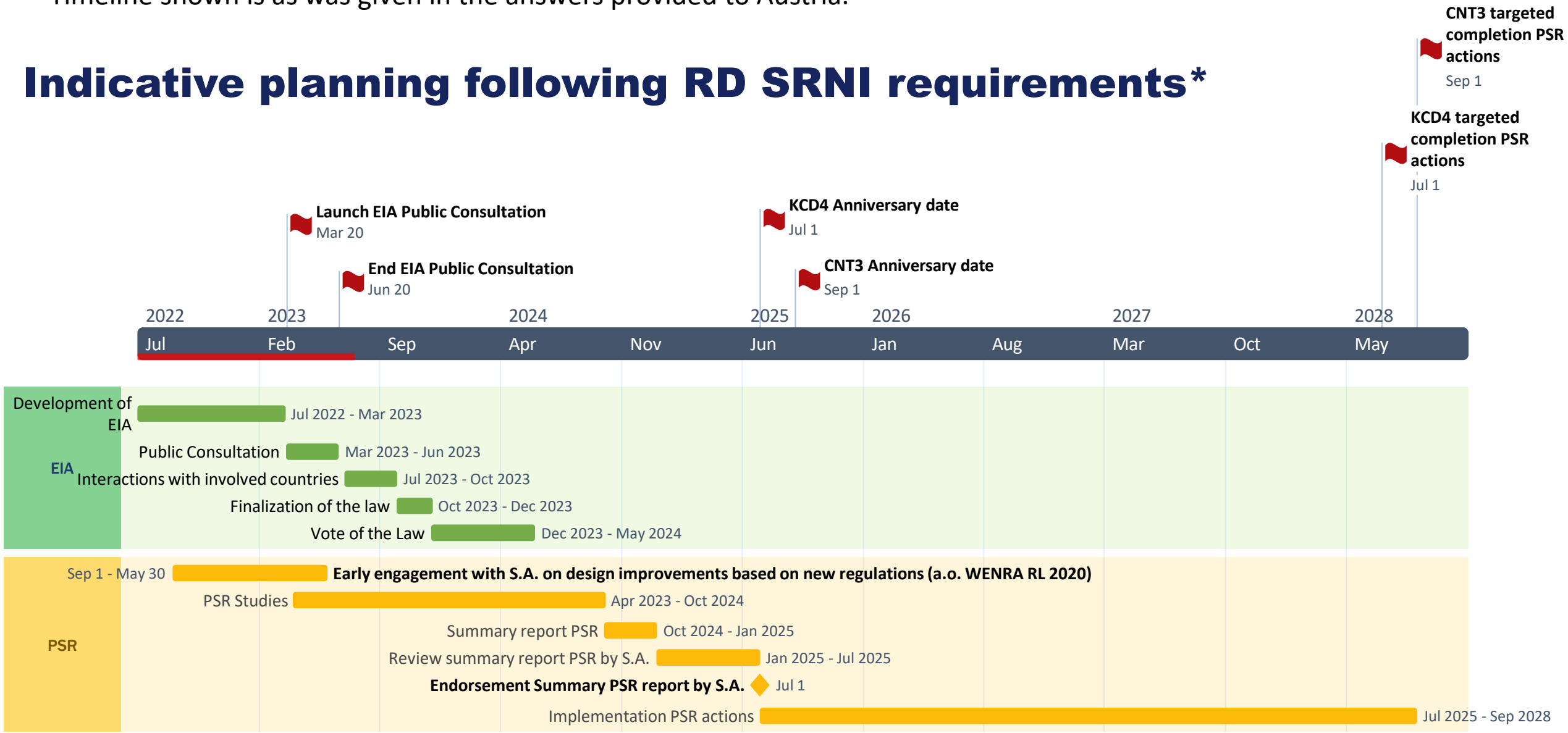


Question 5

Provide the time schedule mentioned in the answer

* Timeline shown is as was given in the answers provided to Austria.

Indicative planning following RD SRNI requirements*



Question 11

Content of the PSR to be undertaken at Doel 4 Tihange 3 units

PSR scope and LTO in frame of PSR

- Content of PSR is legally determined by art. 14 of the Royal Decree of 30 November 2011.
- FANC Requirements for LTO units, which FANC takes into account for the evaluation are published – 20th July 2023 [replaces previous Strategic Note]

  https://fanc.fgov.be/nl/documents/2023-07-20verwachtingen-fanc-lto-d4t3nl

  https://afcn.fgov.be/fr/documents/2023-07-20approche-afcn-lto-d4t3fr
- Prepared in the context of the government's decision to ensure security of electricity supply through the long-term operation of Doel 4 and Tihange 3 NPPs, in particular for the winters of 2025-2026 and 2026-2027.
- The LTO needs to be performed in the frame of a PSR as required by the Royal Decree of 30 November 2011. The PSR is a comprehensive safety review of all important aspects of safety of an existing nuclear power plant (NPP), in which the cumulative effects of plants ageing, and plant modifications, operating experience, technical developments and siting aspects are assessed periodically.
- FANC laid down its expectations regarding the elements that need to be addressed to prepare and justify the long-term operation of Doel 4 and Tihange 3 NPPs.

  ✓specifies the conditions to be met for the operation to resume in the short term (after the 4th decennial anniversary)

  ✓the expectations for further LTO for the new operating period.

  ✓Particular attention is given to some specific areas in the context of LTO: preconditions on plant programs, ageing, design, test & inspections and knowledge, competence & behaviour.

Question 13

Will Doel 4 – Tihange 3 be subjected to an IAEA SALTO review?

- Upon proposal of FANC, BeGov regularly requests IAEA review missions in Belgium: SALTO and FU SALTO at Doel 1 and 2 and Tihange 1, OSART at Tihange NPP in 2023, …)

- BeGov recognizes that IAEA review missions have an added value and FANC regularly evaluates which missions are going to be requested

- All recommendations of previous peer reviews have been considered by the nuclear operator for the ageing management of Doel 4 and Tihange 3 and implemented at the sites:
  - SALTO missions at D12/T1
  - 2020 ENSREG Topical Peer Review

- BeGov currently does not see the need for an additional SALTO mission at this moment.

Question 14

How 3 safety measures Doel 4 – Tihange 3 would be able to comply with FANC requirements for the operation post 2025 ?

Design Upgrades

- The EIA mentioned the most important design upgrades which are considered as envelope with regards to environmental impacts and were used for the EIA.
- Through the different PSR's in the past, Doel 4 and Tihange 3, have undergone multiple design upgrades and improvement projects to ensure compliance with latest safety requirements.
- Besides the PSR projects, also multiple improvements have been implemented in the nuclear sites following international benchmarking, return of experience, … which are enumerated in the Euratom Article 41 notification.
- The WENRA RL 2014 requirements have been analyzed and improvements identified for those units which are to be implemented in the frame of the PSR LTO. The same will occur for the WENRA RL 2020 requirements.
- For the radiological consequences of DBA and BDBA, no safety improvement related to confinement issues has been identified as the plant still meet the Safety Objectives

Question 16: why is NAcP “not followed” for the 1st TPR and whether those are to be implemented now as part of the LTO improvements?

BEST National Action Plan

- In the Belgian Action Plan, the overview of actions is listed in chapter 7.
- It contained in total 8 actions for the Belgian Nuclear Power Plants which have all been progressed and closed out, except for actions 6 and 7 as they were linked to the ‘next PSR’ and not actioned as there was no LTO foreseen until recently.
- The actions are being evaluated in the frame of the PSR LTO and if appropriate the action will be followed and integrated in this PSR LTO for Doel 4 and Tihange 3

NPP 6	Concrete containment structures	Complementary instrumentation is used to better predict the mechanical behaviour of the containment and to compensate for loss of sensors throughout the life of the plant.	The number of sensors on the containment are currently still sufficient for the ageing management program of the concrete containment structure of the NPPs. The adequacy of the ageing management program and an eventual need for compensating for a loss of sensors is to be revaluated in the framework of the review of the dedicated AMP or during the forthcoming PSR. The topic should be addressed in the framework of the forthcoming PSR in Belgium.	Next PSR	If appropriate, the action should be followed in the framework of the next PSRs.
NPP 7	Concrete containment structures	A proactive and comprehensive methodology is implemented to inspect, monitor and assess inaccessible structures or structures with limited access	Guideline ENSI -B01 was not used by ENGIE Electrabel up to now. This document will be evaluated to check what can be applied in Belgium in the framework of the forthcoming PSR.	Next PSR	If appropriate, the action should be followed in the framework of the next PSRs.

Question 18

DEC-B event (CSBO sequence)

DEC – B event

- Accident is initiated by the loss of all Alternate Current power
- Assumptions
  - Failure to return to home load.
  - Loss of first and second level of diesels.
  - The Groupe Moyens Ultimes (GMU) is unavailable
  - Simulation over 10 days (period during which the function performed by direct injection systems and alternative spraying must be ensured before cooling should be resumed by conventional or non-conventional equipment).
  - All safety systems are unavailable, except the passive systems and the minimal set of Structures, Systems and Components (Accumulators; Passive autocatalytic recombiners (PARS); Primary depressurization system; Direct cavity injection (only for Tihange 3); Alternative containment sprays; Containment Filtered Venting System (CFVS))

Question 19: DEC-B event (the CSBO sequence) choice of the scenario

CSBO Scenario choice

The analysis relies on existing Tihange 3 / Doel 4 Probabilistic Safety Assessments (PSA) dealing with the occurrence of internal events

Approach considered to be representative also for external hazards such as seismic events for which the CSBO would represent a relatively more important proportion of the accident sequences

The analysis, based on internal event accidents evaluations concludes that the radiological source term of the CSBO, relied upon for radiological consequences under BDBA conditions, covers 99.99% of the cases

- Firstly, this radiological source term covers 99.99% of the expected ones for BDBA sequences corresponding to sequences without significant fuel damage.
- Secondly, for the 0.01% of BDBA sequences going to core damage, it can be considered that:
  - The source term of the CSBO covers 0.009% of these sequences, either as being bounding or representative
  - The source term of the CSBO is considered arbitrarily and without further investigation as not enveloping for less than 0.001% of the BDBA sequences.
  - Less than 0.001% of the identified sequences in this study are considered as not applicable for the determination of a representative BDBA source term

Question 25: source term for LOCA, FHA and CSBO

Source Terms

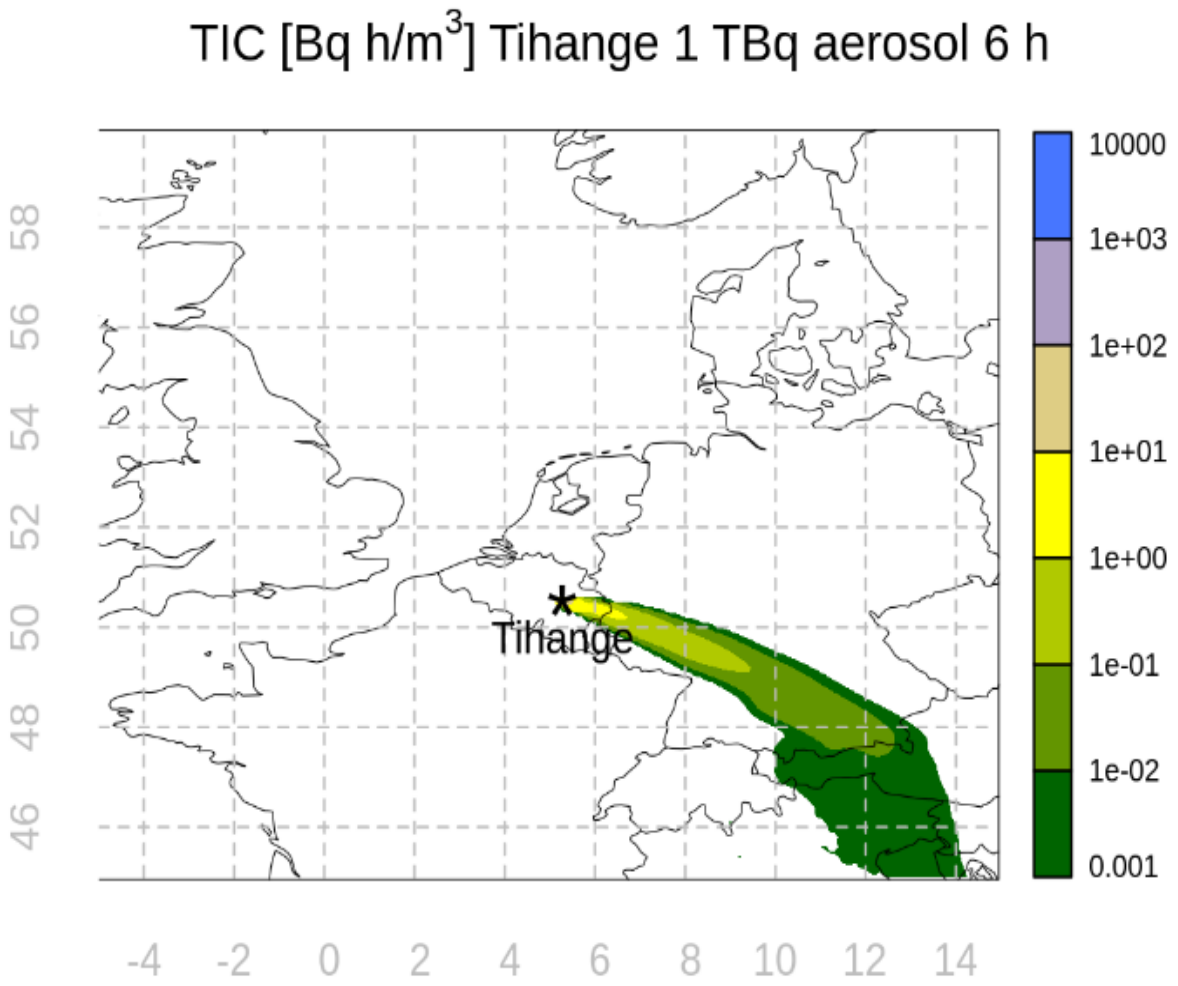
For Design Base Accidents

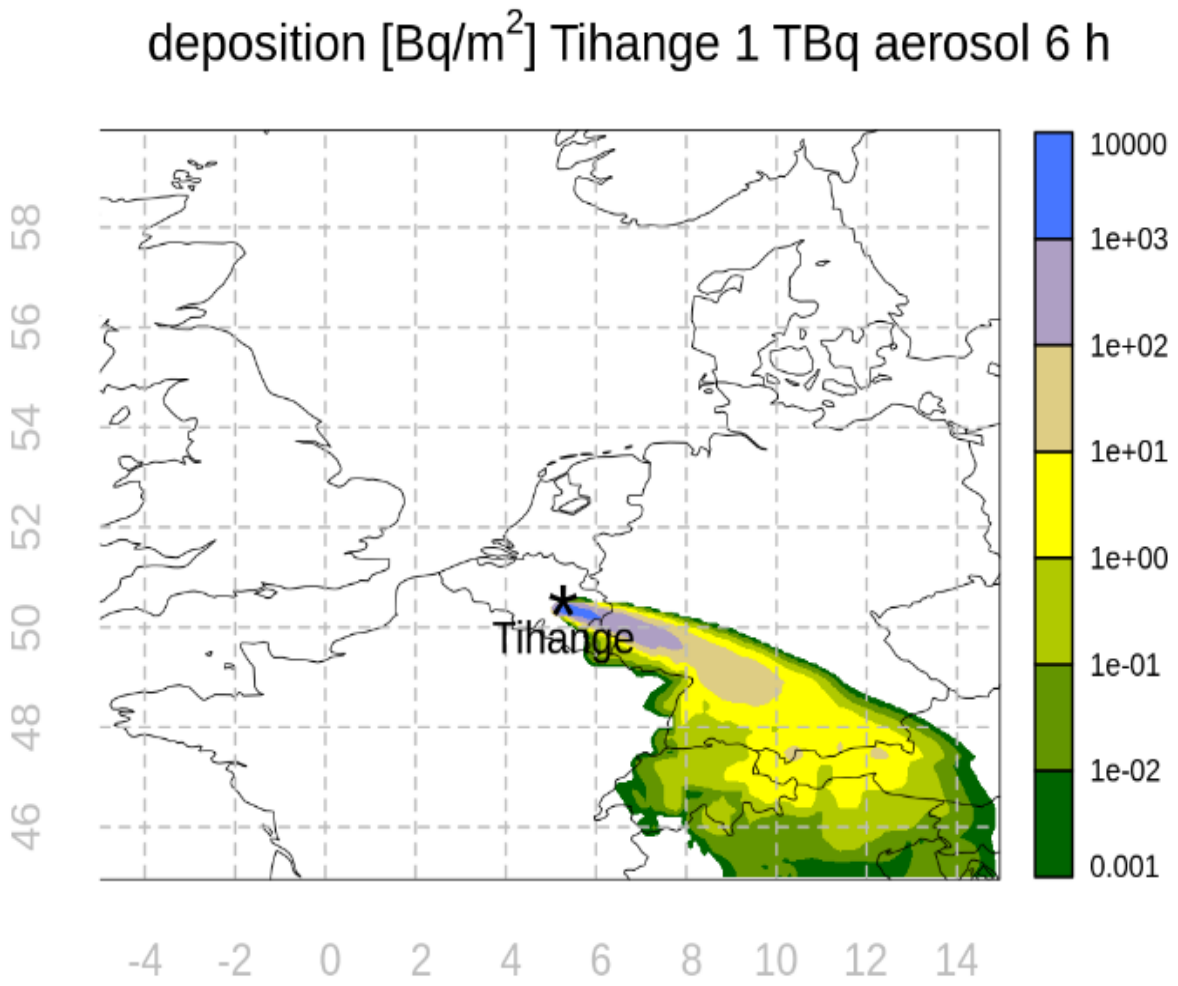
- The core inventory is calculated by ORIGEN for a typical 3-loop 3000 MWth PWR plant
- For LOCA and FHA accidents, the source term released into the containment/building is the one recommended by the USNRC RG 1.195 (which is the successor of USNRC RG 1.25) and use the core inventory calculated by ORIGEN
- The source term to the environment is provided for “most important radionuclide groups” as asked by the Safety Authorities
- Evaluation with new FANC guidelines was made on a voluntary base

For Beyond Design Basis Accidents (CSBO sequence)

- The source term release into the containment is calculated with MELCOR code which is the American reference code for severe accident (SA)
- The source term release into the environment is calculated with MELCOR and ASTEC (European reference code for SA)
  - The mass of radioisotope element, only those linked to iodine behaviour, per location during the Severe Accident sequences (ASTEC)
  - The mass of class of radionuclides per location during the Severe Accident sequences (MELCOR)

Question 27: chart(s) depicting radiological impact prepared for all the concerned geographical area



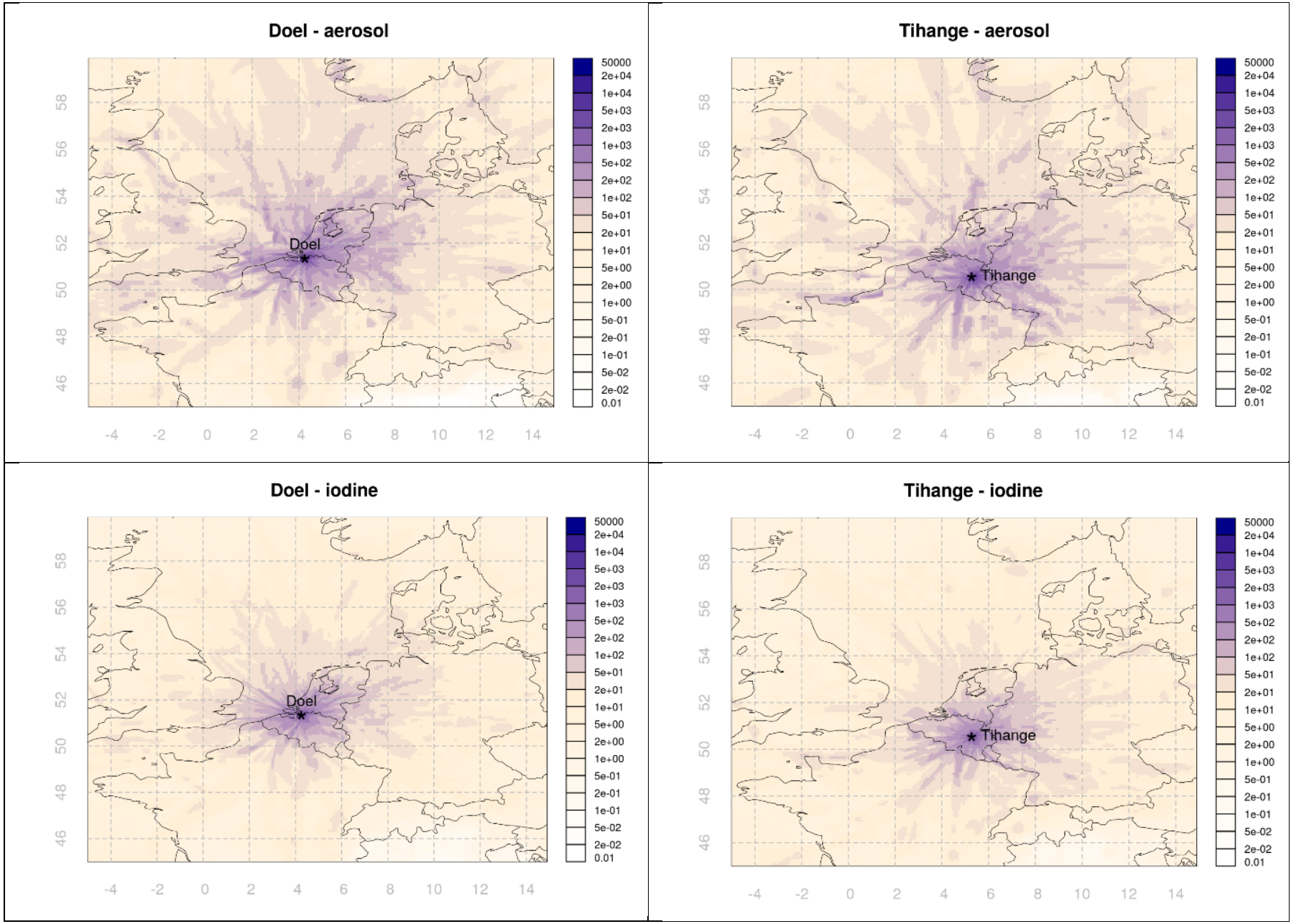


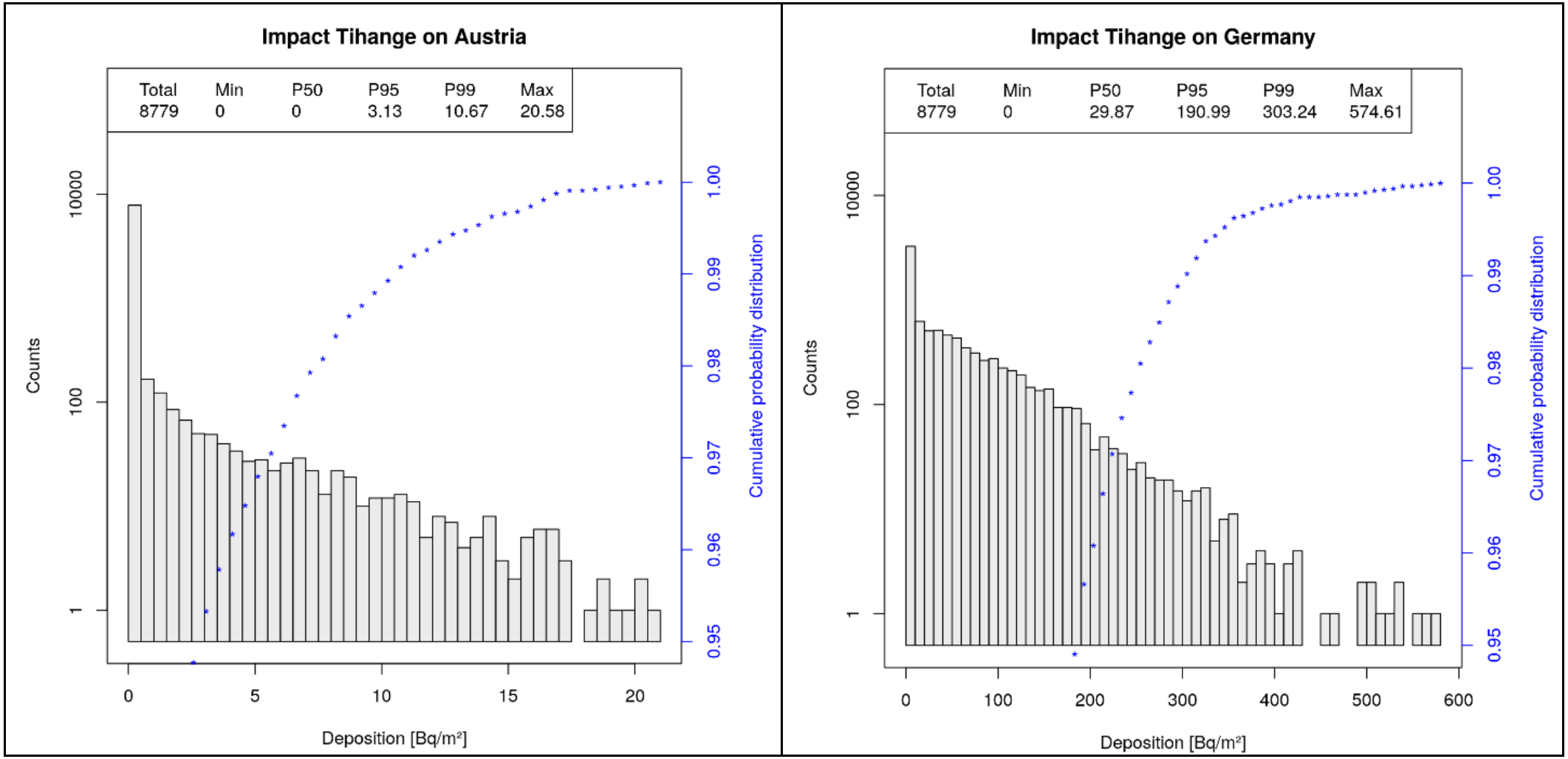
- Results of one of the > 8000 simulations for assessing the impact on Austria for a release with a duration of 6-hours of aerosols (Cs_{137}+Cs_{134}) from Tihange 3. Left the time integrated concentration (TIC) and right the deposition.
- In this case the meteorological conditions are such that Austria is reached, however in >50% of the time/simulations, meteorological conditions are such that Austria is not reached (see further).

Maximum deposition in all locations of the maps over all simulations (>8000) representing the meteorological conditions for a full year (ECMWF data) for:

- Doel aerosols 1 TBq
- Doel iodine 1 TBq
- Tihange aerosols 1 TBq
- Tihange iodine 1 TBq

PS: a difference between aerosols and iodine is made because of a differences in deposition and consequently in depletion of cloud (iodine is considered to be in I_2 form)





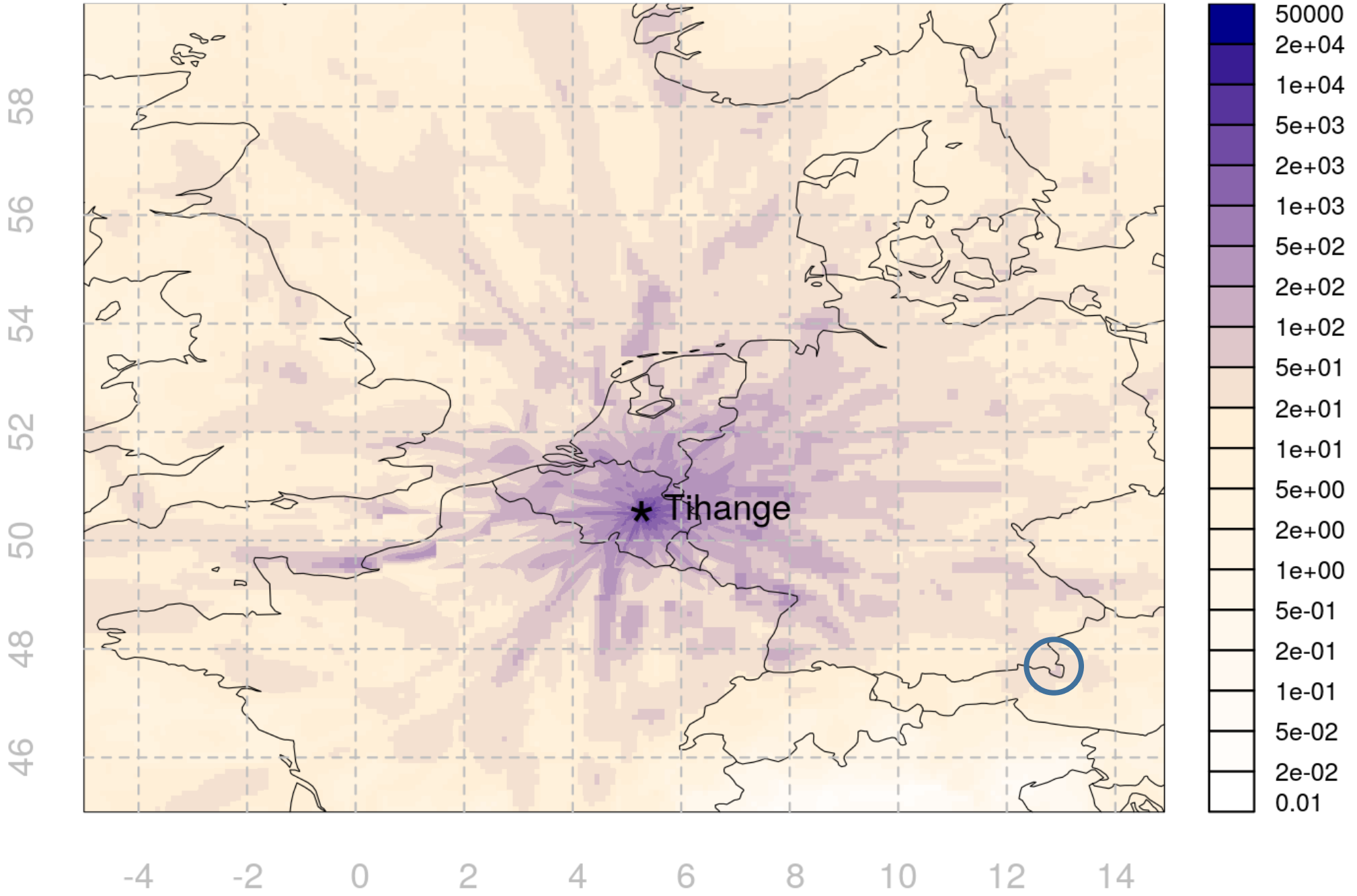
Statistical distribution of the >8000 simulations of maximum deposition value in Austria from a 1 TBq release of aerosols from Tihange 3. For comparison same graph for Germany.
The left axis and black bars show the number of cases (simulations) as a function of the deposition.
More than half of the simulations (meteo conditions) result in no deposition in Austria.
On the right axis and the blue dots gives the cumulative probability (this scale starts only at 0,95!)

Question 28 : profile of the deposition for the pre-Alpine and Alpine areas in Austria.

Facility	species	release duration	country	P50 (median)	P95	P99	P100 (maximum)	Maximum release I131 or aerosol (Cs137+Cs134)	Max deposition in Austria	Comparison max deposition in Germany
		hour		Bq/m^2 per TBq release	Bq/m^2 per TBq release	Bq/m^2 per TBq release	Bq/m^2 per TBq release	TBq	Bq/m^2	Bq/m^2
Doel4	iodine	1	Austria	0	0.89	6.63	36.87			
Doel4	iodine	6	Austria	0	0.95	4.61	15.69	47.99	753.09	8400
Doel4	iodine	24	Austria	0	0.94	2.93	5.10			
Doel4	aerosol	1	Austria	0	0.40	5.17	49.15			
Doel4	aerosol	6	Austria	0	0.46	4.50	36.98	0.06	2.16	23
Doel4	aerosol	24	Austria	0	0.63	2.87	11.26			
Tihange3	iodine	1	Austria	0	3.41	15.51	53.28	5.19	276.42	5000
Tihange3	iodine	6	Austria	0	3.13	10.67	20.58			
Tihange3	iodine	24	Austria	0	2.70	5.05	9.15			
Tihange3	aerosol	1	Austria	0	2.05	20.12	77.17			
Tihange3	aerosol	6	Austria	0	1.83	14.94	54.47	0.38	20.70	342
Tihange3	aerosol	24	Austria	0	2.02	8.39	15.15			

Maximal I_{131} and Cs_{137}+Cs_{134} depositions is Austria over all accident scenarios studied in the EIA and over all meteorological conditions studied (>8000). A comparison with Germany is added.

Indication (blue circle) of maximum in Austria for deposition after a 1 TBq aerosol release from Tihange



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ENVIRONMENT AGENCY AUSTRIA

UVP Doel 4 – Tihange 3

Consultation Report and Final Statement

umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

UVP DOEL 4 – TIHANGE 3

Consultation Report and Final Statement

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Energy, Mobility,
Innovation and Technology

enco

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CONTENTS

CONSULTATION REPORT AND FINAL STATEMENT

This report present the findings and final recommendations gained, after a bilateral consultation took place at Brussels on 13 November 2023.

This consultation allowed to discuss remaining open questions, which arose after the first exchange of questions and answers in written form.

In light of the recent challenges regarding the energy supply, the government of Belgium reversed its earlier decision to proceed with a shutdown of reactors Doel 4 and Tihange 3 (D4T3) in 2025 and instead decided to proceed with the lifetime extension for a period of 10 years.

An agreement between the Belgian government and the operator ENGIE has been reached in principle, though not yet fully formalised (a change of a law is still outstanding). In order to authorise both plants to operate beyond the expiry of their current operating licenses (1st July 2025 and 1st September 2025 for D4 and T3, respectively), the periodic safety review (PSR) and related safety improvements as well as the Long Term Operation (LTO) assessments and related ageing management need to be implemented. An important element of the whole process is the development of the Environmental Impact Assessment (EIA) for the D4T3 life extension, which is needed in accordance with EU Directives and the Belgian law. Of particular relevance for the performance of the EIA is the decision of the European Court of Justice on Case C-411/17 related with the extension of the lifetime for the units 1 and 2 at Doel NPP in Belgium.

The EIA report for the lifetime extension for D4T3 for a period of 10 years has been developed in line with the requirements of the Espoo convention and applicable EU directives. It covers radiological and non-radiological impacts on the population and the environment, including on water, air, climate as well as human and non-human biota. The EIA report has been provided to all interested parties, Austria being among them, because the impact on the Austrian territory in case of a radioactive release from D4T3 in the period of extended lifetime cannot be excluded. Upon receiving the EIA report in Spring 2023, the Austrian expert team reviewed the EIA and documented the findings in the report (UBA report REP-0860, Wien, 2023) covering 5 topical areas, including severe accidents and transboundary impact. For each of those 5 thematic areas, a set of questions was raised, both to obtain additional information and to get clarification of issues that were not sufficiently clear. 28 questions were raised and delivered to the Belgian government. Austria received Belgian answers on 28th August 2023. Those were evaluated by the Austrian expert team, who found that useful additional information and clarification were provided, clarifying the situation on several important issues.

Nevertheless, some of the questions (more precisely 13), covering most topical areas but in particular relevant for the assessment of severe accidents and dispersion modelling/ impact on the environment were not answered in sufficient detail and/or some elements of were missing. In order to have full clarity on all

of the issues, including methods and approaches used in the preparatory analyses and in the EIA itself as well as in the conclusions reached in the EIA, the Belgian government organised the bilateral consultations meeting between the Belgian and Austrian experts that took place on 13th November 2023 in Brussels.

For the consultations, the Belgian government prepared a presentation that summarised the status on all of the 13 remaining questions. Moreover, the presentation was supported with additional information and clarification presented by the experts. Further, all clarifying questions raised by the Austrian delegation were thoroughly answered.

This bilateral consultations greatly helped in improving Austrian experts' understanding of how the EIA was developed, the methodology and underlying assumptions were used. The clarifications and additional information provided allowed a comprehensive (or even full) understanding of the course of action that Belgium intends to pursue in the lifetime extension of D4T3. In this, very important are the regulatory requirement and FANC focus on assuring safety during the LTO up to the final shutdown that is now expected to occur after 2035. The concept of the safety analysis is to be undertaken within the PSR and the implementation of resulting safety improvements (even though the full list of safety measures is not yet available – as the analysis would need to be completed first) was explained. Similarly, the LTO assessments and ageing management focused on required inspections, modifications of replacements were described including some details on the concepts and expected activities.

The severe accident sequences that were used for determining the source term(s), the dispersion analysis as well as the possible impact on Austria were all explained. On the dispersion analysis, the details on both the approach used (i.e. hourly weather and 6 hours release "window") as well as the calculated impact on the most affected area in Austria (Voralpengebiet, where the deposition due to rain is dominant) were shown. The consultation provided the necessary maps and clarifications, enabling a conclusion on the possible impact.

This report summarises the conduct and the conclusion of the bilateral consultation process on each of the areas of interest, focusing on the items and questions that were discussed. However, for a encompassing assessment for the Austrian review of the EIA for the lifetime expression of D4T3, this report should be considered together with the experts option as in the UBA report REP-0860, Wien, 2023.

PROCEDURE AND ALTERNATIVES

The EIA is developed to fulfil the legal requirements in the EU, as specified in the Espoo Convention and in the Environmental Impact Assessment Directive 2011/92/EU). The EIA as presented, including the clarifications provided, fulfils

the requirements. Nevertheless, the LTO for D4T3 is in a way a special case because unlike in other NPP lifetime extension EIAs, the LTO/PSR activities and other actions were not known at the time of the development of the EIA. Consequently, the "final" status of D4T3 as operated post PSR/LTO which (should has been) the basis for the EIA assessment is actually not known. Therefore, for the EIA, the status as of 31st January 2023 is the one modelled.

This situation has an impact on the EIA. In case that the extent of activities to be implemented is such that the facility changes significantly, the current EIA might not cover this new situation. In this respect, the Austrian expert team raised the question whether the conditions in the EIA procedure would have a binding effect on the subsequent procedures. The answer was that in accordance with Belgian law, the EIA is a non-binding procedure. What has been modelled/predicted in the EIA is not binding for any future activities or conditions. Furthermore, given that the final status of the PSR/LTO analysis and subsequent changes on D4T3 is not yet known, a clarification of the course of actions was provided. It was clarified that if there would be major changes to the D4T3 as compared to the situation on 31st January 2023, which was the cut-off date for the EIA (the modelling date), the Belgian law would require that a new (or updated) EIA has to be conducted. This was confirmed by the representative of FANC, who quoted a previous case when the EIA was updated (or redone) following a major change in a facility. These explanations gave comfort to the Austrian experts that, although not legally binding, if the facility were subject to extensive changes, a new EIA would be developed.

Another issue of concern in this area was related to the investigation of alternatives and availability of the electricity supply in case that there is a delay in D4T3 coming back on line. While the assessment of possible alternatives in the EIA is brief and is not supported by deeper analysis (the EIA report refers to various other studies that analysed the alternatives), the conclusion is that without the lifetime extension of D4T3, there will be a high risk to the security of supply in Belgium. This has been confirmed in the consultation meeting, where the eventual non-availability of the D4T3 units as of November 2025 (and even more for winter periods in future years) was termed "unimaginable". Nevertheless, as there was no (clear) timeline of the LTO activities presented in the EIA, Austrian experts understood that the D4T3 will be shut down in 2025, checked and modified and then restarted in 2027. As it was explained during the consultation meeting, the fact of the matter is that D4T3 will be shut down (for a few months) in 2025, then again during the summer of 2026, 2027 and 2028, to allow for all the work on the LTO to be completed. D4T3 will already restart on 1st November 2023, and then restart for a winter operation after each of the LTO outages. After 2028, a normal operation with standard refuelling outage schedules will commence. This is a plausible schedule. Although the details or the scope of neither the LTO related activities nor PSR related safety enhancements are known, a schedule where the work on necessary inspection and modification would be spread over 4 focused outages is considered reasonable.

The information obtained during the consultation also clarified the whole concept of the development and then implementation of the safety and other

measures during the PSR and LTO processes. When the explanation is combined with the timeline of planned activities as presented during the consultation, those were considered plausible.

LONG-TERM OPERATION

The EIA assesses the impact on the environment from the extension of the lifetime of the D4T3 units for a period of 10 years. The status of those two plants as of 31st January 2023 was used as a basis for the EIA. This cut-off date was needed because the actual extent of the LTO activities and the PSR are not known. The Austrian experts were interested to understand how the process of the LTO and PSR and implementation of safety and other modification requirements would be considered to assure comprehensiveness. The Belgian experts first presented the timeline of the performance of the PSR and LTO activities and then explained what the (general) concept of those are. The Austrian experts concluded that those are following international practices and regardless of the short time for the preparation and gradual implementation, there is no specific reasons to believe that those might have a negative impact on the safety of the D4T3 units. All of the activities, those required by the LTO analysis as well as those required from the 4th PSR are now to be completed by July 1st 2028 for D4 and by September 1st 2028 for the T3 unit.

Further discussion clarified that the concept of the 4th PSR for the D4T3 units is in compliance with the applicable Belgian regulations, in particular the Royal Decree of 30th November 2021, specifically its Article 14. This Decree makes it absolutely clear that unless there is a PSR, the result of which the regulator needs to agree with, there will be no operation beyond the current end-of operation date (1st July and 1st September 2023 for D4 and T3 respectively). Accordingly, the PSR is already being worked on, with the target for its submittal to FANC in January 2025, and expected approval by FANC in June 2025, which is still within the currently licensed operating time.

Austrian experts also inquired whether Belgium will invite a SALTO mission in order to independently verify the appropriateness of the LTO, against international standards and experience of the LTO. The answer was that while the IAEA missions have been invited in the past, there are no plans to invite a SALTO for the D4T3 LTO.

Planned design and safety improvements are described rather vaguely in the EIA. The EIA lists 3 modifications as important ones, those being the emergency centre, SNF pools and general improvements to cope with weather extremes including high temperatures. Upon Austrian experts' question during the consultation process, it was clarified that there were multiple improvements in the past and that there might be more resulting from e.g. verification against WENRA RL 2020. All of this was known, the fact of the matter is that D4T3 within their design basis included advanced safety features like bunkered system and

more recently added Filtered containment (FCV). Still no new information on planned new safety measures and their implementation was provided. It is understood that given that the PSR is under development and the LTO is being planned, no specific measures are yet available. Nevertheless, the Austrian experts believed that some of the "ideas" as what would need to be addressed to assure safe operation for the next decade must be circulated between the plants' operator and the regulator. While those are now likely to be preliminary and therefore difficult to share at the moment, sharing the list of improvements at a later date would be appreciated.

The Austrian experts wanted to know the status in relation with the activities that were expected to be implemented as per the Belgian action plan for the TPR, but due to the expected shutdown in 2025 were not. The clarification provided by the Belgian experts indicated that there were two actions, both related with the containment structure and their inspection including the instrumentation and methodology for inspection. With the planned lifetime extension for an additional 10 years, those actions will now be taken on board in the PSR and evaluated accordingly. In the view of the Austrian experts, this is reasonable and will lead to the safety improvements.

ACCIDENT ANALYSIS

The accident analysis and the transboundary impact assessment are, for the countries that are more distant from the NPP units, the most important element of an EIA. This is the case for the D4T3 and its impact on Austria. Therefore, special scrutiny was placed on the review and understanding of severe accidents that were used as the basis for the transboundary impact assessment within the EIA. In this area of interest were the selection of (enveloping) severe accident sequence, the steps and elements within a sequence and the results in terms of effects/source term(s) obtained of importance. In the D4T3 EIA three different accident sequences were used to assess the impact on the environment. Two of those are the design basis accidents (DBA), the LOCA event as well as a fuel handling accident (FHA). Then a long term station blackout with extremely limited operability of equipment, leading to a complete damage of the core and radioactive release from the containment and through the CFV was selected as a representative of the Design Extension Condition (DEC) category B (core damage, DEC-B). From the perspective of a country that is not in the vicinity of D4T3, the FHA scenario is of no interest. The LOCA scenario, which is a design-basis accident and the complete station blackout, which is the DEC-B scenario, are both of relevance. Somewhat unexpectedly, the LOCA scenario leads to a higher impact on Austria than the DEC B scenario.

For the DEC B accident sequence a complete station blackout accident (CSBO) was postulated. It would last for a long time (no restoration was envisaged within the 10 days window covered by the analysis, which is more conservative

than the Post Fukushima Stress Test analysis) with almost no equipment available, leading to the core meltdown and release through two pathways: the containment design leakage (0.25% of the containment volume per day) and the containment's filtered vent (FCVS). Both the DEC B and the LOCA scenario have been previously calculated i.e., not specifically developed with the EIA. In the case of LOCA, the scenario was assessed as a part of the preparation for the operation of the D4T3, as a part of the submittal needed under the EURATOM Article 37. This is relevant because the release estimates from that sequence were based on the deterministic and conservative (design bases) analysis, and represent the status of the plant as it was at the time of the original design. The DEC B scenario was evaluated in the frame of assessments needed to determine the compliance with WENRA RL 2014. Unlike the LOCA scenario, the DEC-B sequence was evaluated using the modern tools and approaches, and its results are the best estimate (rather than conservative, as in the design bases accident). Furthermore, the releases were estimated with the D4T3 being "as -is" now, meaning that new safety measures and equipment were not taken into account. The results indicate a dominant impact on the source term from the operation of the containment filtered vent as well as alternative containment sprays, plus the direct cavity injection for the T3.

During the consultations, Belgian experts explained in more detail both sequences of interest including specific steps and their timing, but also the way the calculations were undertaken. Austrian experts concluded that the sequences were well selected to estimate the impact of the environment. In a case of DEC B sequence, some more details were asked for and provided only verbally, because those were considered confidential. Nevertheless, Austrian experts could understand the main steps as well as the timing of each of those, including the operation of the CFV, which is of high importance for estimating the release source term.

The results of the analysis indicated that the LOCA release, which is a design-basis accident, is a significantly higher source term that the DEC B accident, which is an accident beyond the design basis. This is an unusual result. In case of DEC B, there is a damage/melt of the core leading to the releases from the fuel pellets. The LOCA sequence, in accordance with the applicable guides (RG 1.195), basically limits the release to the content of the gap release, which is also released in the DEC B sequence. The lower release to the environment in the DEC B sequence seems be driven by the functioning of CFV, which reduced unfiltered releases from the containment (during consultations, it was stated "both unfiltered release and CFV release are jointly limited to 0.25% of the containment volume"). The fact that some of the releases are filtered through CFV (in specific DEC B sequence, there are 3 openings of CFV each with ca 4-6 hrs duration) are not, in the view of Austrian experts, enough to explain significantly higher release in the LOCA sequence. Nevertheless, from the perspective of impact on Austria, it is not that relevant because even in the most conservative case (which in this case is the LOCA sequence) the dispersion model shows low impact.

TRANSBOUNDARY IMPACTS

In the terms of the outcome of the EIA, the transboundary impact of a radiological release is the most interesting parameter for Austria. While the EIA report provides good assessment of impact in immediate vicinity, which is particularly relevant for D4 as the border of the Netherlands is nearby, for locations further afield very little information has been provided. There are maximum doses and predictions for depositions for affected locations in the Netherlands, Luxembourg, and Germany, but not for e.g., Austria or other places that are more distant. The transboundary impact was assessed for the normal operations (effluents) and for all three selected accident sequences, two DBA sequences (LOCA and FHA) as well as for the DEC B sequence CSBO.

The transboundary impact was assessed using a detailed numerical step/sequence for each hour of the year 2020 and the estimation of the impacts from a release. It needs to be stressed that the release was summarised/truncated to a duration of 6 hrs, making it conservative. In a case of DEC B sequence, the sequence has been calculated for 10 days and there was a release on-going for the most of that time. While taking weather data over a year is generally expect to be a reasonable averaging of the variability of the weather, it is not necessarily providing the most conservative results. It is nevertheless recognised that other EIAs estimating the transboundary effect has used the same principles.

Apart from the immediate neighbourhood, the transboundary impact is calculated for rectangular area up to 1000 km distance, which includes parts of Austria. The dispersion was estimated using the LaGrange Ches Partikelmodell, with the actual historical numerical weather data provided by ECMWF, for every hour in 2020. The estimates for the Time integrated concentration (TIC) and for the integrated deposition were prepared. The EIA itself did not provide any graphical nor numerical representation as to how it would the expected impact on Austria be.

During the consultations, Belgian experts provided much more detailed results from the impact assessment, including specific values for most affected areas of Austria. With the extensive explanations by Belgian experts, it all became much clearer as to how the analysis was done, how the estimates are to be understood and finally what is the highest impact on Austria in case of a release from D4T3. An example of T3 release of aerosols was provided, where more than 50% of the simulated meteorological conditions are such that there is no impact on Austria. Detailed deposition maps were provided for a 1TBq releases (which allow for scaling up, as the releases in all sequences is at least 100 TBq). The maps that were shared with the Austrian delegation clearly show that the impact on any part of the Austrian territory is low. In addition to graphical presentation, the actual disposition on the territory of Austria has been provided. Related to the 6 hours-duration release of Iodine, the maximum deposition value is 753 Bq/m^2 and 276 Bq/m^2 in a case of a release from D4 and T3 respectively. As Iodine is a short-lived isotope, this deposition is somewhat theoretical, as it

would quickly disappear due to radioactive decay. Respective values for aerosols are 2.16 and 20.7 Bq/m^2, meaning that the values for deposited Cs 137 are well under the lower limit for the introduction of emergency protection measures (the initial monitoring per Austrian emergency plan is triggered with the radioactive deposition being over 750 Bq/m^2). From the figures presented and explanations offered by Belgian experts, it could be concluded that the effect on the Austrian territory due to a DEC-B release (the CSBO sequence selected) at D4T3 is low.

CONCLUSIONS

This leads to the final conclusion that no significant effect for Austria is expected as a consequence of the 10 years lifetime extension for D4T3 units.

It is further recommended to gain information on the results of the PRS and the LTO and the assessment to be performed by FANC. Special attention is given, if this would lead to additional measures, which were not presented as a prerequisite of the EIA assessment. In case that further measures are needed, which could be interpreted as major changes, the Austrian side would like to get informed if such measures would stipulate a further EIA procedure.

As presented during the bilateral consultation a final agreement between the Belgian government and ENGIE had not been reached yet. The Belgian side stated, that this agreement should cover pure financial arrangements related to the LTO of D4T3. If this arrangement would cover additional technical measures – not being presented in the EIA – the Austrian side would like to be informed about them.

ABBREVIATIONS

CFV	Containment Filtered Venting
D4T3	Doel 4 and Tihange 3
DEC-A/B	Design Extension Condition
DBA	Design Basis Accidents
ECMWF	European Centre for Medium-Range Weather Forecasts
EIA	Environmental Impact Assessment
FANC	Federal Agency for Nuclear Control
FCV	Filtered containment venting
LOCA	Loss of Coolant Accident
LTO	Long Term Operation
NPP	Nuclear Power Plant
PSR	Periodic Safety Review
SALTO	Safety Aspects of Long Term Operation of NPPs
TIC	Time integrated concentration
WENRA	Western European Nuclear Regulators' Association

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