

# Summary of Environmental Impact Assessment

**Amendment of the Nuclear Energy Act  
Ministry of Economic Affairs & Climate Policy**

14 June 2024 - Public



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# 1 Introduction and EIA procedure

In its Coalition Agreement in 2021, the fourth Rutte cabinet announced that it wanted to keep the Borssele nuclear power plant (KCB) in operation beyond 2033.<sup>1</sup> The first step in facilitating this is amending the Nuclear Energy Act. Currently, Section 15a of the Nuclear Energy Act states that KCB may not release any nuclear energy after 31 December 2033. It also states that any application for a permit extension will not be considered. The intention is to amend Section 15a of the Nuclear Energy Act so that an application for a permit extension can be considered.

Once the Nuclear Energy Act has been amended, the second step in the process will consist of a permit application to the Authority for Nuclear Safety and Radiation Protection (ANVS) by the operator of the nuclear power plant. The operator of the nuclear power plant will have to demonstrate that the plant can continue to comply with all the relevant requirements which apply in the Netherlands in the long term, including the international standards.

In preparing the amendment to the Nuclear Energy Act, the Ministry of Economic Affairs and Climate Policy (EZK) and the Ministry of Infrastructure and Water Management (IenW) decided to commission an environmental impact report (EIR). The environmental impact assessment (EIA) procedure is an aid to decision making. The purpose of the EIA is to give full weight to the environmental aspect in reaching a decision on a plan or project. The choice for an EIA was made in response to various elements of the overarching legislation which provide grounds for completing an EIA procedure, namely:

- The Espoo Convention (Convention on Environmental Impact Assessment in a Transboundary Context).
- Communication of the European Commission.
- The Aarhus Convention (Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters).
- The European ruling on the Doel Nuclear Power Plant.

The **Espoo Convention** imposes a duty on parties to institute an environmental impact assessment procedure that provides for public participation for proposed activities with a potentially significant adverse transboundary impact. This may relate to a new activity or a substantive alteration to an existing activity. The existence of such a new or altered activity, combined with potentially significant adverse transboundary environmental impacts, mean that under Section 2(3) of the Espoo Convention, an EIA must be drawn up to map out those transboundary impacts.

The proposal for an operating life extension of KCB displays certain similarities with the situation regarding the operating life extension of the Kozloduy nuclear power plant in Bulgaria. The **Espoo Compliance Committee** has determined that the operating life extension of the Kozloduy nuclear power plant was not in accordance with the applicable permits. Although Bulgaria claimed that the modifications were already allowed under the existing permit, the committee concluded that all physical measures, including minor modifications, must be considered. After all, longer operating times can still have potentially transboundary environmental impacts.

The technical studies, which can be used to determine whether the operating life extension of KCB beyond 2033 is safely possible, will not yet be completed before the legislative amendment. Given the current status of this legislative amendment, it is not yet certain whether physical changes to the nuclear power plant are necessary for an operating life extension. Operating life extensions are usually accompanied by physical changes. However, the European Commission suggests that in the case of operating life extensions without physical changes, a transboundary EIA is also required.

The **Aarhus Convention** concerns the accessibility of the relevant environmental information of a plan or project.<sup>2</sup> Article 6 of the Convention sets out the requirements that must be met. The Convention requires European member states to make public participation and decision-making about environmental information equally accessible to all residents.

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<sup>1</sup> The [Coalition Agreement](#) proposes an operating life extension for KCB that will extend beyond the year 2033.

<sup>2</sup> [wetten.nl - Convention - Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters - BWBV0001700 \(overheid.nl\)](#)

The proposal for an operating life extension also displays certain similarities with the situation concerning the operating life extension of the nuclear power plant in Doel (Belgium). According to the ruling by the European Court of Justice, the measures determined by the Belgian Parliament (the legislative amendment) and the modernisation works on the nuclear power plants that were an inseparable part of those measures together formed part of the permit procedure for one and the same 'project'.

Based on the paragraph above, the EIA procedure for the potential operating life extension consists of two phases: the legislative amendment in Phase 1 and the permit process in Phase 2. The EIA procedure will not be completed until after Phase 2. Below is briefly described in which stage which part of the EIA procedure is dealt with:

- Phase 1: exploratory EIA for the legislative amendment.
- Phase 2: EIA for the permit application for the operating life extension

In EIA Phase 1, the environmental effects of the nuclear power plant in the current situation were explored. In addition, the EIA provides – where possible – a glimpse into future environmental effects after 2033. The EIA concludes with an overview of focal points for the second phase. In Phase 2, an actual assessment of the effects on the environment follows. This is because only at that point will it be clear what modifications to the nuclear power plant are needed to keep KCB in operation longer.

### **Existing rights**

The Ministry of Economic Affairs and Climate Policy acknowledges that the question of whether KCB has existing rights cannot be left unanswered, but states that the answer to this question is not yet at issue in Phase 1 of the EIA procedure. This is because the decision to extend the operating life has yet to be made by the operator of KCB and depends in part on the outcome of the ongoing technical studies. Secondly, understanding the existing rights of KCB is not necessary for the objectives of this EIA: mapping out the environmental impacts of the existing situation, extrapolating them beyond 2033 where possible and drawing up an agenda listing environmental focal points that require attention in Phase 2. Thirdly, it is not yet possible to map out the existing rights because the existing rights depend (among other things) on the exact way in which the exploitation of the KCB is continued.

### **Public consultation and participation**

The Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Water Management consider participation with stakeholders and interested parties in the proposed legislative amendment at an early stage to be very important. Between January and April 2023, a plan was drawn up with the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Water Management, in close consultation with the affected municipalities and provincial authority, in order to define participation and communication around this process. This plan focuses on national, regional and local dimensions of this proposal.

An important principle of the participation and communication plan referred to above is that everyone has the opportunity to obtain sufficient knowledge and information in order to be able to form an opinion and take part in the participation process. The primary means of keeping the public informed is the website: [www.overkernenergie.nl](http://www.overkernenergie.nl).

There are a number of statutory procedures for taking decisions. These are set out in the Environment and Planning Act, the Nuclear Energy Act and the General Administrative Law Act. Facilitating public participation is a compulsory part of these procedures. This means that anyone can respond at specific points in time. In this EIA procedure, both the Memorandum on Scope and Level of Detail (NRD) and EIA Phase 1 have taken international public participation into account by translating the summaries and the potential transboundary impacts into English, French and German and providing notifications in the respective countries. In addition, the entire EIA has also been translated into English.

## 2 Decisions on nuclear energy

The Netherlands has set itself the target to be climate-neutral by 2050. According to the National Energy System Plan (NPE), this means that the Netherlands' electricity system must already be CO<sub>2</sub>-neutral by 2035. To achieve this goal, it is necessary to scale up (CO<sub>2</sub>-neutral) energy sources. For nuclear energy, scaling up in concrete terms means extending the operating life of KCB, provided it can be demonstrated that this can be done safely. Nuclear energy has only re-emerged as a relevant energy generation method in the Netherlands in recent years. Whereas in previous decades, efforts were directed at reducing the role of nuclear energy in the energy mix, it now once again appears to be a promising solution for delivering the energy mix.

The following table outlines the decisions that will take place or have taken place in relation to nuclear energy. After all, operating life extension is only one part of measures to achieve the central government's energy goals.

Table 1 Products on nuclear energy over time

Products at the level of national government	Year	Notes	Dependencies
Coalition Agreement Rutte IV	2021	The Coalition Agreement for the fourth Rutte cabinet includes the objective of keeping KCB operational and constructing two new nuclear power plants.	Already completed. Work is currently underway at the Ministry of Economic Affairs and Climate Policy to accomplish these two goals.
Letter to Parliament on nuclear energy, 9-12-2022	2022	The Letter to Parliament dated 9-12-2022 again sets out the government's goals: two new nuclear power plants and keeping KCB operational. It once again emphasises the essential importance of keeping the KCB operational: the plant is already there, its operating life is probably not yet over and it ties in well with a green energy system.	Already completed. Work is currently underway at the Ministry of Economic Affairs and Climate Policy to accomplish these two goals.
National Energy System Plan (NPE)	2023	A vision document laying out scenarios for the energy system of the Netherlands in 2050. It includes nuclear energy, in line with the objective set out in the Coalition Agreement for the fourth Rutte cabinet and the Letter to Parliament of 9 December 2022.	Already completed and now represents the current policy framework for energy projects in the Netherlands.
National Energy Network Programme (PEH)	2023	The programmatic elaboration of the NPE: it highlights spatial planning opportunities/bottlenecks in the national energy network in various energy scenarios. Nuclear energy is part of one of those scenarios.	Already completed.
TenneT system study	2024	The TenneT system study investigates the potential for new energy sources to be incorporated into the energy system. The study highlights the fact that in the Borssele region, the incorporation of new energy sources will become problematic after 2035.	KCB is already part of the energy system in the Borssele region. This will not change. However, if Borssele remains operational for longer it will impose additional pressure on the high-voltage grid because approximately 500 MW of additional energy will be added after 2033.
Broader consideration of the utility and necessity of nuclear energy in environmental terms	2024	The Ministry of Economic Affairs and Climate Policy will provide more evidential support for its position on the utility and necessity of nuclear energy as part of the energy mix and what that will mean for the environment.	The environmental case for why nuclear energy should be part of the energy mix has not yet been made. The Ministry of Economic Affairs and Climate Policy aims to do so now. This will help confirm the utility and necessity of nuclear energy projects such as the operating life extension, the construction of new nuclear power plants and the National Radioactive Waste Programme.
Draft bill for the Nuclear Energy Act	2024	This will comprise the amendment of the Nuclear Energy Act, incorporating the results of the operating life extension EIA and the Explanatory Memorandum.	The draft legislative amendment is currently being considered by the Ministry of Infrastructure and Water Management and the Ministry of Economic Affairs and Climate Policy. The EIA and the Explanatory Memorandum are part of the legislative amendment. The Dutch Council of Ministers (in the event that no new cabinet has yet been formed) will then decide whether the draft can be presented for inspection.

<b>Products at the level of national government</b>	<b>Year</b>	<b>Notes</b>	<b>Dependencies</b>
Decision on the amendment of the Nuclear Energy Act by both Houses of Parliament.	2025	Ultimately, the two Houses of Parliament (Upper and Lower) will decide whether the legislative amendment passes. As soon as the legislative amendment has been passed, the operator of the nuclear power plant can apply for a (new) permit to extend operations of the plant.	After the draft legislative amendment has been presented for inspection, the responses received will be processed. This will be followed by a review by the Council of State. Only then will the government decide on submitting the legislative proposal and will the Houses take a decision on the legislative amendment.
Preference decision on construction of two new nuclear power plants	2025	In parallel, work is ongoing on the second objective from the Rutte IV Coalition Agreement: the construction of two new nuclear power plants. It is expected that the Minister will be able to take a decision on the preferred location, including the plan EIA, in 2025.	The construction of two new nuclear power plants follows from the Rutte IV Coalition Agreement and is related to the NPE and the PEH. The procedure for the construction of the new plants assumes that KCB will remain operational after 2033. Building two new nuclear power plants will also mean an increase in radioactive waste, which will be addressed in the NPRA (below). Added to that is the need highlighted by the TenneT system study to consider how two new nuclear power plants would be integrated into the high-voltage grid.
National Radioactive Waste Programme (NPRA)	2025	The Ministry of Infrastructure and Water Management is currently working on the NPRA that will come into effect in 2025. It draws up a new plan for how to handle our radioactive waste every ten years. The NPRA considers the handling of radioactive waste, i.e. the end of the nuclear fuel chain.	The NPRA has a direct relationship with operating life extension and the construction of new plants, because both involve the generation of more radioactive waste.
<b>Products for the purpose of operating life extension by the operator</b>	<b>Year</b>	<b>Notes</b>	<b>Dependencies</b>
10EVA (ten-yearly safety evaluation)	2023	Every ten years, the operator must demonstrate the safety of the nuclear power plant by means of safety studies. The results are presented to the ANVS for evaluation.	Independent procedure to assure the safety of the nuclear power plant.
SALTO missions (Safety Aspects of Long-Term Operation)	2022-2025	The International Atomic Energy Agency (IAEA) conducts missions for the purpose of ageing management of the nuclear power plant. The results will be included in the follow-up pathway.	Independent procedure to ensure the safety of the nuclear power plant.
Technical studies	2022-2025	The operator of KCB investigates which physical measures need to be taken in order to keep the nuclear power plant safely operational after 31 December 2033.	The performance of the technical studies is dependent on the decision by the Houses of Parliament on the legislative amendment and the results of the safety evaluations.
Permit application	2025-2029	In order to extend the operation of the plant, the operator must submit a new permit application to the ANVS. Aside from evidence concerning safety, the environmental impact assessment (EIA Phase 2) will be considered, including all relevant environmental studies such as the potential impact on Natura 2000.	The permit application is dependent on the legislative amendment and the results of the technical studies. Subsequently, in EIA Phase 2, it will need to be demonstrated that no significant detrimental environmental impacts will occur, or that these will in any event be mitigated.
Contracts	2025-2029	The operator draws up new contracts for the operating life extension. This includes contracts with fuel suppliers, but also contracts with COVRA and arrangements for the storage of radioactive waste in the future.	The contracts are dependent on the permit award by the ANVS, as well as on the options for storing the radioactive waste in a suitable manner (NPRA).
<b>Other</b>		<b>Notes</b>	<b>Dependencies</b>
Insight into the nuclear fuel chain and uranium mining		Uranium mining takes place abroad. Nuclear power plants buy uranium from factories which are able to upgrade it into nuclear fuel from which energy can be obtained. Any environmental impacts from uranium mining must be monitored in the country where the mining takes place.	More uranium will be required if KCB remains operational for longer, and if two new nuclear power plants are built.

This procedure does not address the question 'why include nuclear energy in the energy mix?'. There are other procedures which consider the Netherlands' energy system more widely. In those procedures, multiple questions/subsidiary questions regarding the role of nuclear energy (nuclear energy as part of the mix, dealing with radioactive waste, the relationship to nearby projects, the potential construction of new nuclear power plants) are answered. The Ministry of Economic Affairs and Climate Policy will provide more evidential support for its position on the utility and necessity of nuclear energy as part the energy mix and what that will mean for the environment.

### 3 Background of KCB's operation

KCB is located approximately 1.4 kilometres north-west of the village of Borssele, in the province of Zeeland. KCB is a pressurised water reactor with a thermal power output of approximately 1366 MW and a net electrical power output of 485 MW. The existing nuclear power plant generates around 3.8 terawatt hours (TWh) of electricity per year, representing slightly more than 3% of total electricity generation in the Netherlands in 2021.

Like other power plants, a nuclear power plant converts water into steam. This drives a turbine that rotates a super dynamo. This dynamo, or generator, converts the released energy into electricity. The major difference between a nuclear power plant and other power plants is the heat source. In a nuclear power plant, water is heated by the heat released by nuclear fission of uranium. The heat released by the fission of uranium and plutonium nuclei is used to heat water and produce steam. This steam then drives turbines that generate electricity.

The mining and enrichment of uranium (required for the production of nuclear energy) is a CO<sub>2</sub>-intensive process that takes place repeatedly. However, total CO<sub>2</sub> emissions are (relatively) low in relation to the amount of electricity that can be generated from uranium. Nuclear energy, compared to other energy sources, offers a number of advantages. The area of land used during the life-cycle of nuclear energy is minimal. The high energy density of fuel elements and the small footprint of nuclear power plants results in a high energy production per square metre.

## **4 Legislative amendment**

As a first step towards an operating life extension for KCB, the Nuclear Energy Act needs to be amended. This EIA is an appendix to this amendment to the Nuclear Energy Act and the related Explanatory Memorandum. The object of the legislative amendment is to remove the obstacle to applying for a permit to operate for a longer period of time.

## 5 Scoping exercise

The EIA contains a description of the current environmental impacts of the nuclear power plant. Environmental impacts can take different forms, such as pollution of air, water and soil, depletion of natural resources and loss of biodiversity and (nuclear) safety. Mapping out the existing environmental impacts of KCB will produce relevant insights into the potential environmental impacts of the legislative amendment. The environmental impacts of KCB and the knowledge gaps identified together make up an agenda of environmental issues to be considered in a potential EIA Phase 2.

The environmental annual reports of EPZ (Elektriciteits-Produktiemaatschappij Zuid-Nederland) are one of the sources that have internationally been used to shed light on the existing environmental impacts of KCB. The environmental annual reports of KCB are publicly accessible. The existing situation is defined as the period from 2017 to 2022. This period is representative of the situation as it currently pertains at KCB. The existing ecological situation is an exception to this. The 'existing ecological situation' has been defined as the situation today, i.e. up to and including the time of writing of this report (early 2024).

In addition to a description of the environmental effects of current operations, the EIA also contains an extrapolation of environmental impacts (where possible) beyond 2033 and an agenda listing environmental aspects relevant in the next phase of the permit process.

Based on the results of EIA Phase 1, it can be concluded there are no direct obstacles to the proposed legislative amendment beforehand. In Phase 2 of the EIA, all environmental impacts must be reconsidered and assessed again, for the purpose of the permit application for the intended extension of the operational lifespan itself. Table 2 outlines the points of attention for Phase 2 per sub-aspect.

*Table 2 Points of attention for Phase 2 per sub-aspect*

<b>Sub-aspect</b>	<b>Requires attention</b>
Nature	Requires significant attention, specifically species and area protection.
Radiation protection	Requires attention, must be in compliance with laws and regulations in all cases.
Nuclear safety	Requires attention, must be in compliance with laws and regulations in all cases.
Water	Requires attention, specifically water quality (in relation to sub-aspect Nature).
Health and safety	Requires attention, must be in compliance with laws and regulations in all cases.
Soil	Requires no additional attention, must be in compliance with laws and regulations in all cases.
Noise	Requires no additional attention, must be in compliance with laws and regulations in all cases.

## 6 Ecology

### 6.1 Current situation

Several impacts of KCB's activities may affect the current ecological situation. Examples include the extraction and discharge of cooling water, disturbance and degradation due to the production of noise, light and/or movement, turbidity and sedimentation, pollution due to the release of foreign substances and the release of nitrogenous gases. The environmental effects of these impacts have been investigated. This investigation included consideration of how these impacts may generally affect flora, fauna and their habitats. The extent to which the impacts play into KCB's regular operations (where, how much, how often, in what form) was also clarified. The investigation shows, among other things, that nitrogen deposition from KCB is a maximum of 5.50 mol N/ha/yr. For habitat types in (approaching) overburden situations, the maximum nitrogen deposition is 5.15 mol N/ha/yr. Approximately 70,000 m<sup>3</sup> of cooling water per hour is used, which is heated and returned to the Western Scheldt. Sometimes together with environmentally foreign substances for the maintenance of the systems.

To determine environmental impacts, it is also important to get an idea of the current state of the ecological system. This has been done from low to high in the estuarine food chain. This is a difficult task since ecosystems are complex and changeable. The condition of the biotic communities in the Western Scheldt appears to be downright variable. There are many negative influences at play, but the system also has positives. The current status of various biotic communities around KCB is summarized in the paragraphs below.

The condition of the phytoplankton community is variable. For instance, eutrophication and flourishing of cyanobacteria appear to be limited (positive). On the other hand, an undesirable invasive species often exceeds the desired standard and over the past decade there has been some algal bloom activity (negative) several times. A very limited quantity of information is available on the zooplankton community in the Western Scheldt. As a result, the current situation cannot be clearly interpreted.

The condition of the aquatic and coastal vegetation is also variable. For instance, seagrass is barely still present and the vegetation zones of salt meadows display an unnatural ratio (negative). On the other hand, there has been a gradual improvement in terms of quality and the area covered over recent decades.

The condition of macrofauna is variable. Biomass, density, species-richness and species diversity are predominantly good in both the littoral and sublittoral and display a positive trend. The number of invasive exotic species is relatively very high, however, and the key species of cockle is not present in sufficient biomasses. The situation of the key species mussel is not known.

The condition of fish varies per functional group of fish species and per zone of the Western Scheldt. The highly and weakly polyhaline zone (where KCB is located) is rated positively for biomass but negatively for diversity. The biomass of diadromous species (migratory fish) is limited in all zones. The species that symbolize good water quality, smelt and twaite shad, display a falling and rising trend, respectively. Historically, huge quantities of herring were caught periodically, but these catches have fallen sharply in recent years.

The status of more than half of the identified breeding bird species is negative. This is partially attributable to the unnatural proportion in vegetation zones of salt meadows. A positive point is that the available surface area of suitable breeding habitat for breeding birds has increased as a result of (local) restoration and management measures. The situation of more than half of the identified non-breeding bird species is also negative. In particular, the number of herbivores and benthivores is falling. Causes mentioned are insufficient availability of food, rest, but also external causes.

Developments in the common and grey seal populations are both positive. The number of common and grey seals in the Western Scheldt has grown very substantially since 2000. The proportion of pups of the common seal is also well above the critical level of 9%.

## Nitrogen

During regular operation of KCB there are various processes at work and equipment is used in the course of which the nitrogen-containing substances ammonia (NH<sub>3</sub>) and nitrogen oxides (NO<sub>x</sub>) are released. Examples include the use of emergency power generators and boilers, venting of ammonia and the use of vehicles for the transport of equipment to and from the business location, and for the transport of staff. In the Natura 2000 area Western Scheldt & Saeftinghe, habitat types receive the highest nitrogen deposition from KCB: up to 5.50 mol N/ha/yr. For habitat types in or near an overburdened situation, the maximum nitrogen deposition is 5.15 mol N/ha/yr.

## Cross-border effects

Ecosystems and the interactions within them do not stop at national borders. This means that the environmental impacts of KCB on the biotics may also be transnational.

## 6.2 Extrapolation of environmental situation and look ahead to EIA Phase 2

Ecosystems are complex. Changes are constantly taking place, among other things as a result of abiotic variations and human influence. The dynamic and the many interactions which underlie those changes cannot be completely fathomed. Due to this complexity, it is virtually impossible to make a realistic prediction of what the condition of an ecosystem will be in the future. What is clear is that various autonomous developments will bring about changes to the future ecological situation around KCB.

Relatively rapid abiotic changes and the increasingly frequent extremes may have an increasingly negative impact on the populations of many species in and around the Western Scheldt. It is likely that the potentially less resilient populations of characteristic and susceptible (protected) varieties, populations and biotic communities are more susceptible to the pressure factors of KCB.

Nature restoration projects can give a positive impulse to (protected) species, populations and biotic communities and their resilience.

Ecology is an important component for EIA Phase 2. Several activities of KCB, especially cooling water extraction and discharge, pollution and nitrogen deposition, potentially exert relatively high pressure on the ecosystem. This emphasises the need for a more detailed ecological assessment in EIA Phase 2. **Nitrogen deposition** is an important criterion that requires further investigation for EIA Phase 2, subpart ecology. Any knock-on effects on animals are also relevant. **Extraction and discharge of cooling water** is an environmental criterion that requires further investigation for EIA Phase 2, subpart ecology. In particular, with respect to effects on the zooplankton community (including larval macrofauna and fish), phytoplankton community and fish community. **Pollution** in general is an issue requiring attention for EIA Phase 2 with regard to ecology. In particular for marine mammals as they are very susceptible to the accumulation of pollutants.

A further assessment will be necessary within the framework of Natura 2000, Water Framework Directive (WFD), Flora and Fauna, and Nature Network Zeeland (NNZ). This will be part of EIA Phase 2. An important (legal) aspect here is any existing right of KCB. It may greatly affect the required content of the ecological assessments in EIA Phase 2. In EIA Phase 2, if necessary, mitigation measures can be explored and put forward. These are measures that could compensate for or ameliorate significant negative impacts.

## 7 Radiation protection during regular operations

Ionizing radiation is the name for all radiation of high energy that can ionize substances. In this process, an electron is released from an atom. This can cause damage to the material in which this atom is located. When this occurs in living tissue, it can lead to health damage in humans and animals. Therefore, exposure to ionizing radiation should be limited to a level as low as reasonably achievable. In a nuclear power plant, the main source of ionizing radiation is the reactor core. This emits mainly fast (high-energy) neutrons and gamma rays. Neutrons are released during the fission of uranium or plutonium nuclei.

Humans and other organisms can be exposed to ionizing radiation in different ways. Exposure pathways are 1) direct radiation from the installation or from radioactive substances present in the installation or present on the KCB site, 2) discharges to the air of radioactive gases and aerosols or radioactive substances that are discharged into waste water.

The radioactivity of a substance is also called 'activity' and is expressed in the becquerel (Bq). This describes the number of atomic nuclei that decay radioactively per second. Thereby, 1 Bq is equal to 1 radioactive decay per second. The radiation dose received at a given location and for a given dwell time is expressed in Sievert (Sv). This is the unit used to express the biological effect of an ionizing radiation on body tissue.

### Health effects of ionizing radiation

Exposure to ionizing radiation can affect health. This is because ionizing radiation causes damage in the DNA material of body cells. Most DNA damage is repaired by a repair mechanism, but in some cases it fails. DNA damage that is not repaired, or not repaired properly, can cause health effects, such as the occurrence of cancer, decades after exposure.

If the DNA damage in a cell after radiation is so great that it can no longer be repaired, it leads to cell death. As long as a single cell is involved, cell death is not a problem, after all, we have plenty of body cells. In other words, if the number of cells dying from radiation is limited, we will not see any adverse health effects. Adverse health effects do occur at extremely high exposures.

## 7.1 Current situation

### Radiation at and around the nuclear power plant

The National Institute for Public Health and the Environment (RIVM) has estimated that a resident of the Netherlands receives an average total effective annual dose of 2.8 mSv. The largest contribution to the total average annual dose in the Netherlands comes from radiation in the indoor environment (radon, thoron, gamma radiation from building materials), radiation from medical diagnostics (such as computed tomography, CT scan) natural radioactivity in the body and cosmic radiation. The contribution from industry, consumer products and fallout (from nuclear weapons testing) together is less than 1% of the total effective annual dose per member of the population. KCB is part of industry, but contributes very little to the radiation dose within this sector.

Occupationally exposed workers are classified as category A and B, with strict requirements for radiation protection knowledge and medical supervision. Radiation hygiene facilities and measures, such as shielding, protective clothing and monitoring of radiation levels, are applied to reduce personnel exposure. Employees wear dosimeters (EPD and TLD) and the dose values are stored centrally in the National Dose Registration and Information System (NDRIS).

Non-occupationally exposed employees may not receive more than 1 mSv of effective dose annually.

The maximum radiation exposure outside the nuclear power plant site is measured and corrected, with values well below the permitted limit. RIVM measures the radiation dose rate around the nuclear power plant and occasionally notes small increases due to transport of radioactive waste. All transports meet the legally permitted values for dose rates.

All radioactive waste from the nuclear power plant will be transferred to COVRA for safe management and future final disposal. Spent nuclear fuel is sent to France for reprocessing, during which uranium and plutonium are recovered and the remaining material is mixed with molten borosilicate glass and poured into steel containers. This highly radioactive waste, known as 'vitrified waste', is stored in vertical silos at COVRA. Eventually, all radioactive waste at COVRA will be placed in a deep geological final disposal facility, for which research has been conducted to identify suitable geological formations such as rock salt and Boom Clay. COVRA has mapped out the amount of waste and there is currently enough storage space for the nuclear plant's waste. If the nuclear power plant remains in operation longer or new nuclear power plants are built, more land area may be needed in the future.

### **Radiological emissions into the air and water**

A contribution to the radiation exposure is the dose due to radiological emissions during normal operation via the air and via surface water.

Emissions to the air do not only concern emissions of radioactive substances into the atmosphere, but also radioactivity indirectly deposited on the ground. Calculation of the dose effects from these emissions for the population assumes continuous emissions for 25 years and a dose contribution through the various exposure pathways: 1) inhalation, 2) external radiation due to radioactivity in a passing cloud, 3) external radiation due to radioactivity deposited on the ground, 4) ingestion as a result of consumption of home-grown vegetables, milk and meat products produced in the surrounding area.

Work takes place in KCB throughout the year and some of it takes place in the radiological zones. Employees working in radiological zones may be exposed to a higher dose of ionizing radiation than the background radiation. The plant has many facilities and measures in place that limit the dose that personnel can receive. Thus, there is adequate shielding from sources of radioactivity. Where necessary, protective clothing is worn to prevent radiological contamination. The ventilation system prevents the dispersion of any radioactivity in the air by removing that activity through filtering.

The maximum radiation exposure outside the nuclear power plant site is caused by the radioactive substances in the various plant buildings. This radiation exposure is caused by radiation from radiological emissions and direct radiation from buildings and objects on the business site during normal operation.

In addition to emissions to the air, radiological emissions also occur to surface water. It is assumed herein that after 25 years of discharge, the concentration in marine organisms is in equilibrium with the concentration in the water. By discharge to surface water, the population is exposed through the following exposure pathways: 1) ingestion of seafood, inhalation of sea spray, inhalation of resuspended sediment. The nuclear power plant meets the requirements in terms of discharges to air and surface water.

### **Cross-border effects**

During normal operation, gaseous emissions can occur in the atmosphere, which are carried and diluted by the wind. The degree and direction depends on the wind strength and orientation. The emissions comply with the applicable discharge limits and the maximum radiation exposure of the population amply complies with the statutory criteria. As the distance increases, the radiation exposure will further decrease.

In addition, there are emissions to the Western Scheldt. These emissions comply with the applicable discharge limits and the maximum radiation exposure of the population amply complies with the statutory criteria. These emissions can reach the nearest land border via the Zeeland-Flemish coast. The transport route of radionuclides in the Western Scheldt and North Sea is complex and the dispersion of liquid emissions in water is more localized and subject to local conditions. Given the distance from the nuclear power plant to the Belgian North Sea coast, the doses in Belgium due to liquid emissions will be lower than calculated for the reference person in the Netherlands.

For direct radiation, the dose rate decreases as the distance increases. Assuming a point source, the dose rate decreases quadratically with distance. At a distance of more than 16 kilometres, this effective dose will no longer be detectable compared to the naturally occurring background radiation. The transboundary effect of the radiation exposure is therefore negligible.

## **7.2 Extrapolation of environmental situation and look ahead to EIA Phase 2**

If KCB continues to operate after 2033, it is expected that all legal requirements regarding radiation protection, including the requirements regarding emissions to air and water, will continue to be met in a similar manner as now.

When planning to build new nuclear power stations, it is up to the initiators to demonstrate that their impact on the environment with regard to radiation protection will be sufficiently low and will comply with the relevant regulations.

No bottlenecks and/or knowledge gaps have been identified as environmental focal points for EIA Phase 2 with regard to the operating period after 2033 for the Radiation Protection sub-aspect.

## 8 Nuclear safety

### 8.1 Current situation

Most of the radioactivity is in the reactor core. The design of a nuclear power plant must demonstrate that possible accidents are controlled and that the consequences, such as discharges of radioactive substances, remain within statutory criteria. Thermohydraulic analyses are used to calculate the installation response to assumed initial events and demonstrate that the consequences are controlled. Radiological analyses are used to calculate the consequences of discharges and the dose to the environment. The design is based on design accident control and radioactivity containment. Conservative assumptions and modelling are used in these analyses. The results of the analyses show that the installation can be kept safe after initial events and that the safety objectives are guaranteed. These analyses are included in the safety report of the nuclear power plant.

A nuclear power plant must further demonstrate that the allowable risk to nearby residents from off-design accidents meets the applicable criteria. To demonstrate this, it is international practice to conduct a probabilistic safety analysis (PSA). The PSA involves a systematic examination of the likelihood of accidents leading to nuclear damage and their impact on the environment. The process involves three levels: determining the risk of nuclear damage, assessing the exposure on the safety envelope and determining the radiological consequences for people and the environment. For individual risk, the risk of death from short- and long-term effects is calculated, with special attention to the most vulnerable group, namely 1-year-old children. The group risk is presented as a cumulative frequency distribution, showing the chances that a certain number of people become victims of possible accident scenarios. The results show that both the individual risk and the group risk remain well below the statutory criteria. The PSA results were reported in the safety report of the nuclear power plant, which describes the assumed events, the installation response, and the evidence of safety.

The nuclear power plant is operated within the principles of the safety analyses, which have demonstrated that the nuclear power plant can be operated safely. EPZ's approach to its aging management results in controlling the aging effects of safety-relevant systems, structures and components. This ensures that systems, structures and components with a nuclear safety function are available and reliable.

#### **Cross-border effects**

For the environmental aspect of nuclear safety, no cross-border effects are to be expected. The impact assessment of allowable risk resulting from accidents for nearby residents concluded that both the individual risk and the group risk amply meet the applicable assessment criteria. The same applies here, namely that the maximum is located in the immediate vicinity of KCB and that as the distance increases, the location-related risk will further decrease. Due to its distance from the Belgian border, the risk is negligible and therefore also for more distant countries bordering the Netherlands.

### 8.2 Extrapolation of environmental situation and look ahead to EIA Phase 2

The safety analyses will need to be renewed for operations after 2033 based on then current regulations and guidelines.

Climate change impacts seawater and air temperatures, sea level rise, and extreme weather events. For the current situation, it has been demonstrated that KCB's cooling systems can provide sufficient cooling at the maximum possible water temperature, even in accident situations. It has also been demonstrated for the current situation that KCB is adequately protected from seawater and flooding. For a longer operating period beyond 2033, these aspects will have to be demonstrated for the then assumed maximum possible water temperature and maximum seawater levels.

When planning to build new nuclear power stations, it is up to the initiators to demonstrate that their influence on KCB's nuclear safety will be sufficiently low.

Before KCB can continue operating beyond 2033, all systems, structures and components with a nuclear safety function must be demonstrated to be available and reliable for the anticipated period of operation. This is done on the basis of technical investigations, safety studies in accordance with the then current law, regulations and guidelines under the supervision of ANVS as regulator.

The above extrapolation leads to the following environmental focal points for EIA Phase 2 regarding the operating period beyond 2033:

- Updating the safety analyses for the purpose of testing the control of design accidents and their possible radiological consequences, and the risk criteria for the individual and group risk for off-design accidents.
- Updating the assessment of any transboundary effects of accidents.
- Demonstrating that the safety-relevant cooling systems, even in accident situations, can sufficiently cool Western Scheldt water at the maximum possible water temperature to ensure nuclear safety.
- Demonstrating that air cooling in safety-relevant buildings, including in accident situations, can provide sufficient cooling at the maximum possible air temperature to ensure nuclear safety.
- Demonstrating that adequate protection of KCB is in place against the maximum seawater levels to be assumed to ensure nuclear safety.
- Demonstrating that adequate protection of KCB is in place against the maximum wind speeds to be assumed to ensure nuclear safety.
- Demonstrating that the effects of aging of systems, components and structures with a nuclear safety function are controlled for the intended operating life extension.

Demonstrating that in addition to the technical aspects of aging, the organizational, procedural and administrative aspects have also been sufficiently addressed in the LTO program.

## 9 Water

### 9.1 Current situation

KCB extracts cooling water from the Western Scheldt and discharges heated water into surface water after use by an installation. Groundwater is only used as an emergency supply for cooling in case the emergency and cooling system is not available. The Scheldestromen Water Board, the regional governing body charged with management of the groundwater, is responsible for issuing permits for groundwater extraction.

KCB is located within a polder that is part of the local water system of Walcheren and Zuid-Beveland. The water quality of the Western Scheldt is influenced by various factors, including discharges from the Borssele polder pumping station, polder pumping stations in the Sloe area and the sewage treatment plant. Water from the nuclear power plant and the decommissioned conventional power plant is discharged into the environment. KCB drains into a watercourse from where the water is discharged into the Western Scheldt via weirs and a pumping station.

The water system of the Western Scheldt is important for the extraction and discharge of cooling water. In case that Western Scheldt water is not available, an emergency cooling water reserve system has been installed at the nuclear power plant using 8 wells to the (saline) groundwater. The water quality of the Western Scheldt is affected because the nuclear power plant discharges heat through the water. In addition to radioactive substances, non-radioactive substances (e.g. caustic soda, hydrochloric acid, iron sulphate) are also discharged.

For the cooling water discharge from KCB, (limited) transboundary effects may occur. The temperature rise of the discharged water can increase by less than 1 °C at a distance of about 3.4 km from the discharge point near the Dutch border. The discharge plume and heat plume have a limited range and are estimated to be an order smaller (0.25 to 5 km) than the distances to the borders with Belgium (25-50 km).

#### Cross-border effects

For the environmental aspect of water, no cross-border effects are expected. The range of the plumes is limited.

### 9.2 Extrapolation of environmental situation and look ahead to EIA Phase 2

Due to climate change, sea levels are rising and precipitation is less predictable, with drier summers and wetter winters (extreme weather conditions). These changes may affect the operation of KCB. The increase in water temperature may make it more difficult to use water from the Western Scheldt for cooling. This may result in limited water extraction. In addition, discharging water from the cooling water system can also become a problem because it leads to the discharge of more heat into already warm water.

Because of climate change, we are experiencing warmer, drier summers more often. This leads to drought and a decrease in the availability of ground and surface water. This negatively affects both water quality and water quantity. Any future restrictions regarding the extraction of (saline) groundwater may affect the availability of the emergency cooling water system of the nuclear power plant. Climate change may also have a negative effect on recreation, mainly due to its influence on water quality. During drought and periods of low discharge, the concentrations of (chemical) substances in the water increase. This affects the swimming water quality of the swimming location, the Kaloot, immediately west of KCB.

Water quality is the main environmental focal point for the environmental aspect of Water. A water emission test in a future permit grant provides detailed insight into the effects of the cooling water discharge on the water quality of the Western Scheldt. In addition, modelling of the heat plume and discharge plume is needed to better understand the range of effects of the cooling water discharge.

## **10 Health and safety**

### **10.1 Current situation**

The subject of safety related to KCB has other aspects besides nuclear safety. For example, storage of hazardous substances and extinguishing gas, the functioning of emergency power generators and disaster management. EPZ reports on KCB's annual performance in its annual environmental reports. Based on information from the annual reports, it follows that KCB operates within the limits of its permit with respect to conventional safety.

#### **Cross-border effects**

There are no cross-border effects for the environmental aspect of Health and Safety.

### **10.2 Environmental focal points for EIA Phase 2**

If business operations continue in the current manner, no changes in the effects of the conventional aspects are expected. There are no environmental focal points for EIA Phase 2.

## **11 Soil**

### **11.1 Current situation**

Various activities have taken place in the immediate vicinity of the nuclear power plant: a coal-fired power plant northwest of the nuclear power plant and a fly ash storage facility east of the nuclear power plant. Based on the soil risk document, in the current situation there is a negligible soil risk for all soil-threatening activities of the nuclear power plant. In addition, all contamination and remediation contours from the soil file are located outside the nuclear power plants and these contours are located in the immediate vicinity elsewhere on the cadastral plot.

#### **Cross-border effects**

There are no cross-border effects for the environmental aspect of Soil.

### **11.2 Environmental focal points for EIA Phase 2**

The protection of soil quality is laid down in current legislation and regulations. EPZ adheres to the measures and provisions stipulated in the permits issued, thus soil hazardous activities have no consequences. A deterioration of soil quality is not expected in the future. If incidents or soil-threatening activities demonstrably result in soil contamination, a duty of care applies. Soil contamination that occurs after 2023 must be remediated. There are no environmental focal points for EIA Phase 2.

## **12 Noise**

### **12.1 Current situation**

KCB is located in the zoned Vlissingen-Oost industrial park in Borssele. The nuclear power plant basically operates 24 hours a day. The noise emission of the nuclear power plant is mainly determined by the noise radiation from the machine hall via ventilation grilles and glass facades, fans and exhausts on the roof of the machine hall, steam pipes, the AT transformer, the cooling water pump building and the cooling machine on the roof of the office building. Every five years, noise measurements verify that the nuclear power plant complies with the permitted noise levels. Based on the results of measurements and calculations, noise levels at several measurement points appear to have increased since 2015. However, the nuclear power plant amply complies with the applicable noise regulations.

#### **Cross-border effects**

There are no cross-border effects for the environmental aspect of Noise.

### **12.2 Environmental focal points for EIA Phase 2**

Operation of KCB after 2023 is expected to have no or limited impact on the environmental aspect of Noise. It is not clear whether the operating life extension of the nuclear power plant will change existing noise sources or whether new noise-producing installations will be introduced. If this were the case, the nuclear power plant would have to respect the area value determined for the site in question. Also, the combined noise from the nuclear power plant with the rest of the industrial park will have to respect the established noise zone and limit values for homes in the zone. The assessment of the area value and the incorporation into the noise zone is the most important environmental point of attention for the exploitation phase.

# Colophon

## SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT AMENDMENT OF THE NUCLEAR ENERGY ACT

### CLIENT

Ministry of Economic Affairs & Climate Policy

### PROJECT NUMBER

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### OUR REFERENCE

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